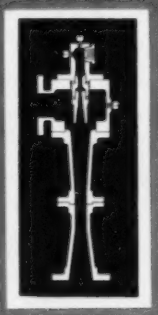
OIL, GAS AND PETROCHEMICAL PROCESSING

Petroleum Refiner

DECEMBER
1958

A SPECIAL REPORT ON EJECTORS



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QUICK ESTIMATES
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BRIGHT FUTURE
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For a "Quick Look" at this issue, turn the page . .

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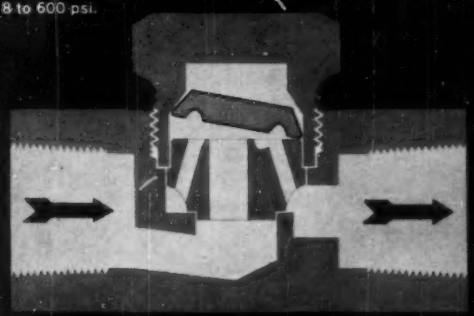

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YOUR ANNUAL INDEX

On Page 174 you will find PETROLEUM REFINER'S 1958 Editorial Index. Here is a handy guide to all of the useful information which has appeared in the past year. It incorporates a number of improvements in index procedure.

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PETROLEUM REFINER, published on the 12th day of each month. Second class postage paid at Houston, Texas.

Petroleum Refiner

OIL, GAS AND PETROCHEMICAL PROCESSING

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A Quick Look

at This Issue

These handy digests permit checking ☑ the articles you want to read first.

SPECIAL REPORT ON EJECTORS

☐ **Ejectors Have Wide Range of Uses . . .** Ejectors can be used singularly or in stages to create a variety of vacuum conditions. They also can be operated as transfer and mixing pumps. Use the handy check lists in this article to be assured of the right ejector for the right job. Turn to **Page 95.**

☐ **Figure What An Ejector Will Cost . . .** The cost of an ejector system must be compared with the operating cost of steam and water in order to find the most economical system. These data will help you size pre-condensers and inter-condensers, estimate ejector costs, and predict steam and water consumption. Turn to **Page 101.**

☐ **How To Get The Most From Ejectors . . .** To insure trouble-free operation of ejectors, review these points concerning installation and inspection. It's a surefire method for trouble shooting and a helpful review of material properties for construction which will enable you to get the most from your ejector installation. Be sure to turn to **Page 106.**

☐ **Computer Gives Best Splitter Design . . .** In general, a fractionator has narrow ranges of operating and design parameters which lead to optimum economic operation. Here are data on a pentane splitter to show how this can be done. Turn to **Page 111.**

☐ **Stream Analyzers Cut Ethylene Cost . . .** The ethylene process is one of many important processes where you can save money through use of adequate instrumentation. Here is an example which shows a pay-out in less than four months. **Page 115.**

Please Turn Page ➔

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A Ljungstrom air preheater reduces slagging and cuts boiler downtime by boosting combustion air temperature, in some cases by as much as 1000°F. Whatever fuel you use, hotter combustion air makes it burn more cleanly and completely, with less slag and deposits.

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For further information on potential fuel economy, write today for your copy of a factual article by O. F. Campbell describing one company's fuel savings with a Ljungstrom air preheater. Call or write The Air Preheater Corporation.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

A Quick Look at This Issue . . .

☐ **New Hydrogen Sulfide Corrosion Curves . . .** Recent laboratory data improves the reformer corrosion rate prediction. The original iso-corrosion rate curves published in 1956 did not cover the range of hydrogen sulfide concentrations—but these curves do! And the result is a new tool for refinery corrosion engineers. For complete details, turn to **Page 119.**

☐ **Heat Transfer Nomographs (Part 3) . . . Correction factor for film velocity and Reynolds number . . .** These three nomographs are useful in determining basic factors in heat transfer calculations. Film velocity correction factors and Reynolds number for liquids and gases can be quickly determined by using these nomographs. More time-savers, clip and file, turn to **Page 121.**

☐ **How CO_2 Removal Plants Are Working . . .** Operating data from first two plants show successful use of the hot potassium carbonate process to natural gas. You can profit also from the trouble shooting done by these two plants on their initial operating problems by turning to **Page 123.**

☐ **Small Refinery Gives Turnaround Lesson . . .** Sinclair's Wyoming refinery learned that group efforts works better than a planning staff when preparing for a turnaround. This system is the result of 15 years of trial and error and will work for your small refinery. The first step is **pre-preplanning** which starts immediately following a turnaround; then planning continues until the next turnaround. For complete details, turn to **Page 129.**

Your Annual Index

PETROLEUM REFINER has followed the practice for some years now of including in its December issue the Annual Editorial Index covering the 12 issues for that year.

The 1958 index appears in this year as an insert opposite Page 174. It is called to your attention so that you might take whatever steps your situation calls for in preserving it for reference.

A number of improvements in indexing procedure have been effected in this 1958 compilation, all designed for reader convenience. If you find that other changes toward this end are needed and will memo the editor, they will be considered for the 1959 Index. Separates of the 1958 Index may be had by addressing Editor, PETROLEUM REFINER, Box 2608, Houston 1, Texas. These extra copies, where needed, are furnished free to subscribers.

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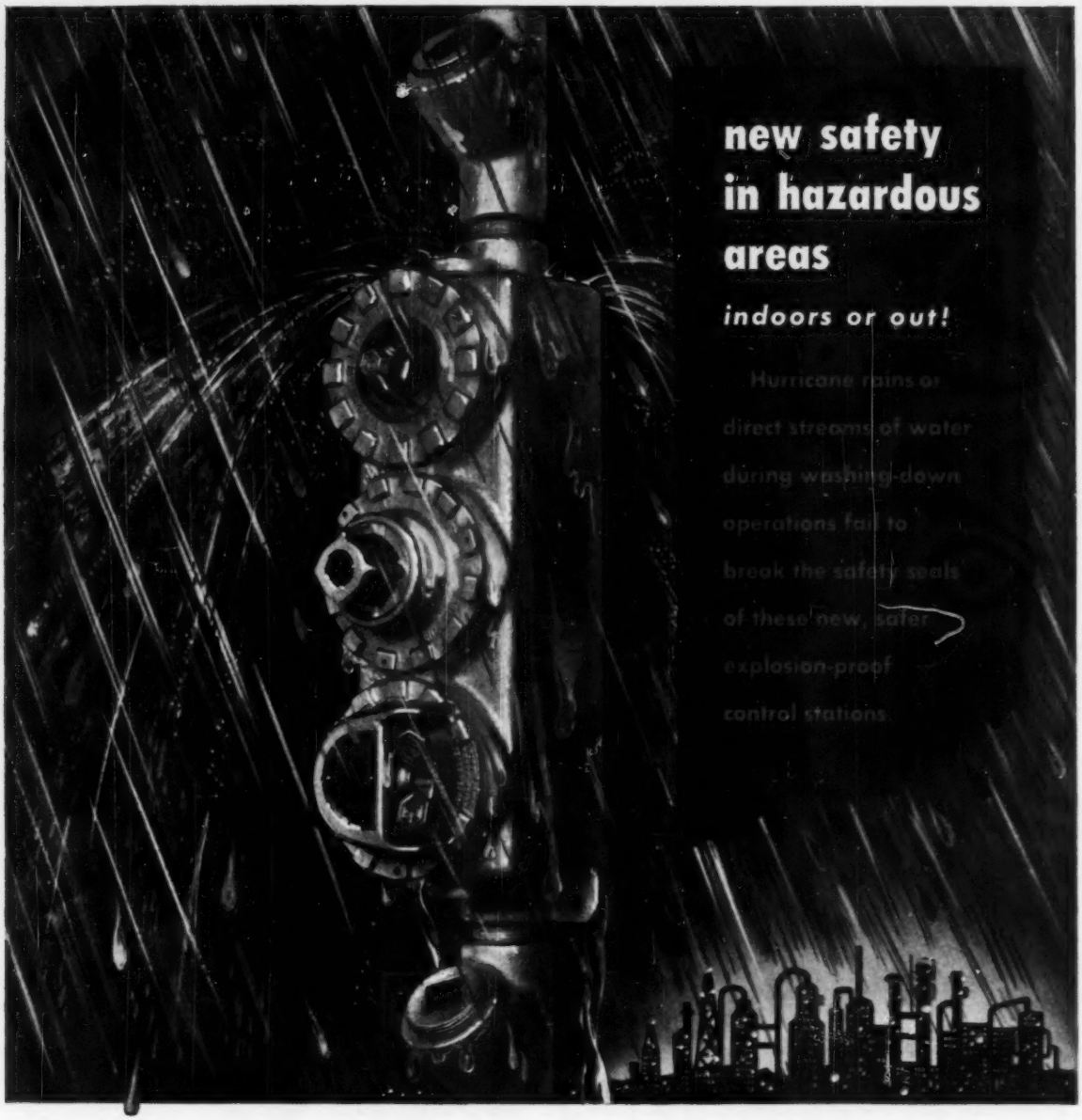
☐ **Which Alloy For High Temp. Processes? . . .** Here's how you can select the proper alloy for the high temperature range of 1300-1400 F. Two processes, thermal cracking of hydrocarbons and steam-methane reforming are the basis for this high temperature study. They also show you where and why various alloys are used in this service. For complete details, turn to **Page 133.**

☐ **Estimate Cost of Fractionation Systems . . .** Thirty different fractionation systems were compiled to come up with the cost generalizations given in this article. You can review the four typical systems to see how these data were obtained and learn how you may use them for future estimates. Ready for your reading on **Page 141.**

☐ **The Engineer and His Two Friends . . .** The engineer's initial reaction when dealing with computers is that he's bound in a number of straightjackets. Then along comes the answer which brings the two together—the general-purpose program. Here's how all three can work together in perfect harmony. Turn to **Page 165.**

☐ **Your First Invention—A System . . . How to Invent: Part 5 . . .** A system does not enter into the inventive thought process. However, it does contribute a great deal to preparation for invention. As a prospective inventor, you will ultimately have to work out your own individual process for inventing, but here are some points which form the basis for any system. You'll find them by turning to **Page 175.**



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PIPE LINE INDUSTRY and The PIPE LINE COMPOSITE CATALOG for the oil and gas pipe line industry.

Petroleum Refiner is indexed by Industrial Arts Index, Chemical Abstracts and by Engineering Index, Inc. Microfilm copies available through University Microfilms, Ann Arbor, Michigan.

Refresher Time

THIS IS BEING WRITTEN before, but by the time you read it the annual conference of PETROLEUM REFINER's Editorial Staff will be history. This year we are meeting near Brackettville, Texas at old Fort Clark which used to be a Mexican border cavalry outpost for Uncle Sam's army. In addition to our entire staff and GPC executives there were to be in attendance five industry guests, specialists in the several facets of oil, gas and petrochemical processing. Two and a half days were to be spent around the conference table. Planning the editorial program for 1959 and 1960 was down as No. 1 on the agenda although, certainly, a lot of post-mortems on previous issues were scheduled. These conferences invariably do a great job for the editors and through them for PR readers and the entire industry. We come out with good, sound ideas—many brand new—that will redound to the benefit of all as the months come and go. This carefully planned conference approach to our editorial problems has been followed by our staff ever since PR was established in 1922. The practice has continued over the years because results invariably have been high on the plus side.

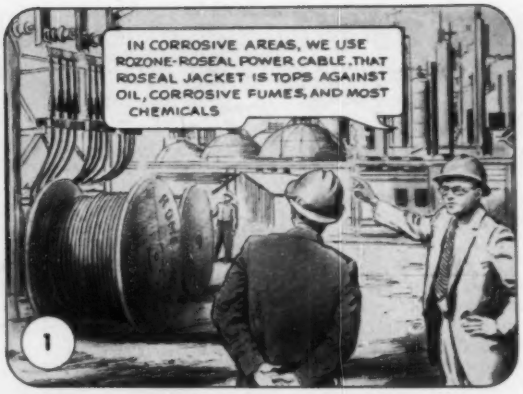
Pleasant Dream!

WE'RE GIVING AWAY no GPC trade secrets when we tell you that our Circulation Procurement man calls PR's Process Handbook Issues (*Refining* in September of even years and *Petrochemicals* in November of odd years) "a dream of an instrument for use in my work." He promotes these to a fare-ye-well and subscriptions in most acceptable quantities result. The reason, of course, is obvious. The September Handbook, as one of our readers says in The Mail Box (Page 84) is of great value both as reference and in training plant technicians. Many a PR reader keeps one or both of these Handbooks within easy arm's reach as they go about their duties. And we get a lot of satisfaction from the words of commendation that come back to us about their usefulness. Incidentally, the Handbook sections of both the September 1958 issue and the November 1957 issue are available as separates and can be had at $1 each by addressing PR's Reprint Department, Box 2608, Houston 1, Texas.

The Edmister Gap

WE HAVE HAD some queries about the popular Edmister series, "Applied Hydrocarbon Thermodynamics" which ran regularly January through September but skipped October and November. Here's the reason for the gap: Wayne C. Edmister, the author, is on a year's leave from California Research Corporation and is teaching at Oklahoma State University, Stillwater. Because of complications and confusion accompanying this change, Chapter 10 was delayed but it will appear in the January, 1959 issue.

DANGER! CORROSION AT WORK...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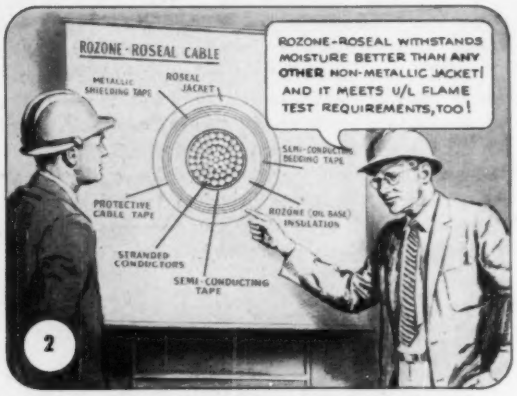

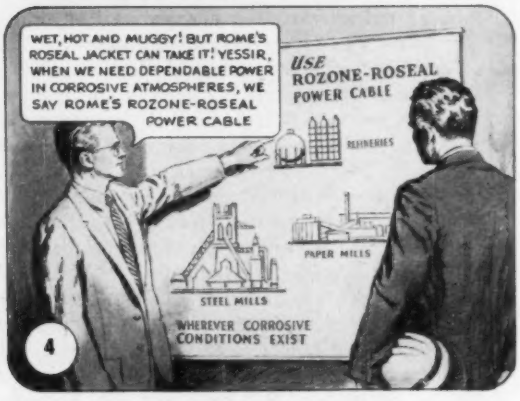
WET, HOT AND MUGGY! BUT ROME'S ROSEAL JACKET CAN TAKE IT! YESSIR, WHEN WE NEED DEPENDABLE POWER IN CORROSIVE ATMOSPHERES, WE SAY ROME'S ROZONE-ROSEAL POWER CABLE
USE ROZONE-ROSEAL POWER CABLE
REFINERIES
PAPER MILLS
STEEL MILLS
WHEREVER CORROSIVE CONDITIONS EXIST
4

A matter of FACT

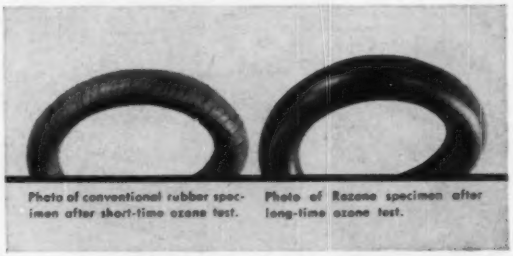

Photo of conventional rubber specimen after short-time ozone test. Photo of Rozone specimen after long-time ozone test.

Rozone insulation is high in dielectric and impulse strength and has excellent resistance to corona and ozone cutting.

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A Quick Look at the Industry THIS MONTH

Unions Prepare for Gulf Coast Strike . . . Strike may take 26,000 Gulf Coast refinery and chemical workers off jobs by Christmas—but decision rests on O. A. Knight, OCAW president. At first, union demanded wage boost based on cost of living and worker productivity. After management argued recession cut deep into profits, union switched demand to straight 25-cent hike.

In Kansas City, too, OCAW and Sinclair deadlocked on wages. Sinclair negotiator contends company will reject all proposals involving pay increase.

On top of this, you can bet unions are devoting long hours planning organization of white-collar factions. In chemical industry, for instance, number of production workers rose only 5 percent in past ten years—but office personnel increased many times that. Union officials realize unless white-collars are organized, unions will lose economic and political strength.

Still—crafty unions recognize hesitancy of clerical, technical and professional people to align with present unions. Therefore, they are considering separate unions with air of distinction and professional touch.

Upswing in Plastics Forecast . . . U.S. Rubber chairman, H. E. Humphreys, Jr., predicts tremendous rise in world plastic production during the next ten years. Production could reach 27 billion pounds by 1968 he contends—three times 1958's output.

Along same lines, annual market for chemicals used with rubber (synthetic and natural) in U.S. estimates at $500 million. Each pound of the 1,475,000 tons of new rubber consumed in '57 was accompanied by about two pounds of non-rubbery materials.

Future Sales Not Certain . . . Future gasoline sales cannot always be counted on to follow vehicle growth. Example: number of vehicles in United Kingdom increased last year but vehicle use dropped. Result: lower over-all consumption.

Oil Data Denied Russians . . . Commerce Department gave o.k. to some U.S. firms to give Russia technical data for non-military products. At same time, however, department turned thumbs down on granting technical data for license applications relating to refining plants and certain petrochemicals and plastics.

Compression Ratios Easing Off . . . Detroit is backing-off slightly on some new car compression ratios. Reason: present premium fuel differs between brands and locality so autos requiring peak octanes sometimes aren't satisfied.

While talking about octanes, researchers add another factor in measuring how gasoline satisfies engines. In past, laboratory ratings (F-1 and F-2) and over-all hydrocarbon type were used. Now, distribution of hydrocarbon types according to boiling point is considered important—high boiling olefins worse than low boiling olefins according to car's acceptance.

For volatility tolerance, recent Shell studies show auto engine fuel measures better with new scale based on temperature at which malfunction occurs. Scale accounts

for variables of RVP, atmospheric conditions, and fuel boiling range by converting to equivalent temperature corrections.

Air Force Ponders Gelling . . . U. S. Air Force simulating high altitude to study gelling of synthetic hydraulic and lubricating fluids. Data reveal some "condensed aromatic ring compounds" may be used as antioxidant additives to retard gelling.

Amoco Closing Old Refinery . . . American Oil closing and dismantling its Destrehan, La., refinery because of technological and economic reasons. Company considered "mothballing" facilities—also converting to asphalt plant, but decided against both. One snag though: Union (OCAW) is trying to block plant closing.

Quick Look Around the Country . . . API survey predicts 0.9 percent hike in U.S. refining capacity by September, '59 . . . **Latest count shows unions winning 68 percent of** bargaining elections held by NLRB in third quarter this year—reversing recent downward trend . . . **Defense planners push $30 million plan** to disperse oil storage across country—with some sites underground.

Sees Hike in Oil Demand . . . Recent prediction says U.S. petroleum demand should rise 4 percent or more in '59—free world hike might hit 11 percent.

Air Pollution Control Costly . . . Latest estimate reveals oil industry has spent $66 million on air pollution control since 1956. In addition, another $1 million goes out yearly for research.

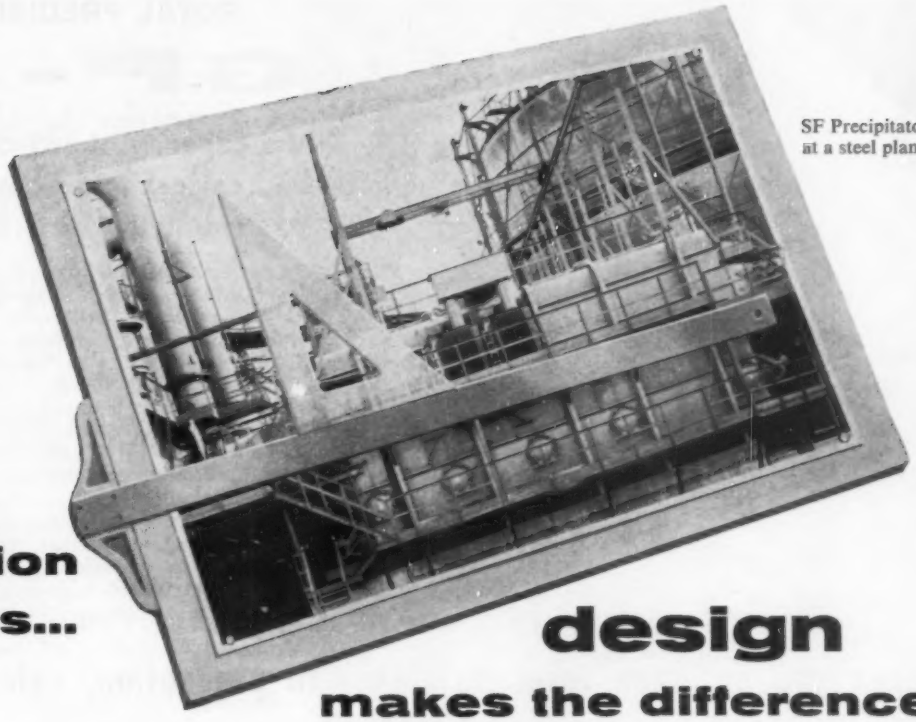
Nylon, Rayon Skirmish Continues . . . With nylon continuing to ease into tire cord market, rayon producers haven't been idle. Recently developed high-strength rayon cord (Tyrex) may give nylon good race. Joint development of five major producers, current ads omit mention of "rayon." Plugged as superior fabric, some are considering it only for premium tires.

Now nylon has about 40 percent of tire cord market—but mostly through replacements. Rayon continues to grab 99 percent of original equipment tires.

Death Knell for Auto Grease . . . Trend to fewer lubricating fittings with longer intervals between auto grease-jobs forecasts doom for grease. Too, auto industry predicts chassis fittings will soon be eliminated from new models—therefore auto population increase will give no relief.

Polyethylene Exports Still Look Good . . . Despite much foreign capacity coming onstream, domestic exports of polyethylene for '58 should hit 225 million tons—about 30 percent of production. Reason is most overseas production is linear polyethylene—still leaving big market for conventional type. However, as the foreign demand is fulfilled with own production, U. S. exports will dwindle.

Trend to Commercial Power . . . As refineries get larger, look for more to turn to large utility systems for electric power. Processing units now require reliable and economical power capable of starting 10,000 or larger hp motors. Few refinery power stations have this incremental capacity.



SF Precipitator at a steel plant.

In Dust Collection Systems... design makes the difference

Higher efficiency of Buell 'SF' Electric Precipitators is the result of exclusive engineering features. For example, Buell's *Spiralectrodes* emit 50% to 100% more electrons than other types . . . and *maintain* their efficiency. Positive gas flow control through adjustable baffles prevents scouring and eddying. And Buell's Unique Continuous Cycle Rapping practically eliminates "puffing".

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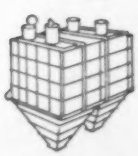
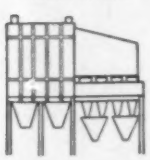
Lower installation cost of Buell's time-proved simplified design makes erection faster and easier. Spiralectrodes, for example, are self-tensioning, require no weights. Flexibility of power supply means easier installation, operating safety.



"SF" ELECTRIC PRECIPITATORS

Lower maintenance cost is the result of many details of superior design. And sectionalized design permits shutting down part of a unit without interrupting service in the rest of the unit.

Get full information: write for a copy of "Buell SF Electric Precipitators", a 22-page booklet. Write to Dept. 21-L, Buell Engineering Co., Inc., 123 William Street, New York 38, N. Y.



PRECIPITATOR-CYCLONE COMBINATIONS

buell®

Experts at delivering Extra Efficiency in **DUST COLLECTION SYSTEMS**

ROYAL PRECISION

LGP-30

Twice the capacity of any computer in its class...easiest to program in basic machine language...lowest in cost

With the compact, powerful LGP-30, you can obtain peak operating efficiency through on-site linear programming...can save substantially on every barrel produced by faster, simpler selection of (1) optimum-level production, sale and purchase of gasoline, butane, naphtha etc.; (2) severity level of the catalytic reformer; (3) tetraethyl lead content.

Because the LGP-30 is mobile, you can now have high-speed electronic computation *wherever you need it.* Operating from any convenient wall outlet, the self-cooled LGP-30 gives you memory (4096 words) and capacity comparable to computers many times its size and cost.

The lowest-priced complete computer you can buy, the LGP-30 has been so simplified that even non-technical personnel quickly grasp its operation. A library of sub-routines and programs is maintained – as well as an active users organization. Service facilities are available coast-to-coast.

Gives you optimum level efficiency in production, sales, purchase!

Other important jobs now being assigned to the LGP-30 in numerous petroleum installations include the following: pipeline problems; mass spectrometer calculations; analysis of oil field production; flash point calculations; pumping and batching scheduling; correlation of seismic records; reservoir engineering studies; well-logging interpretations.

ROYAL McBEE

data processing division

For further information and specifications, write Royal McBee Corporation, Data Processing Division, Port Chester, N.Y.

Where lead gives useful corrosion control

in liquid Sulphur Dioxide process vessels and piping

H
O
O=S=O
O
H

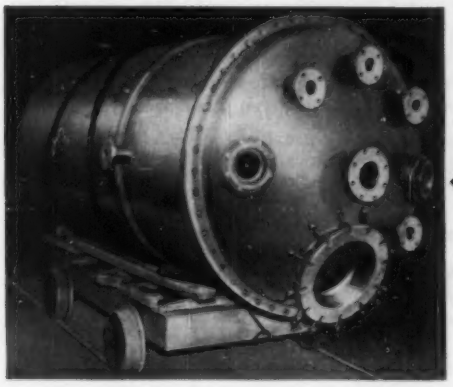
Hot SO_2 vapors and other oxidation products present in liquid SO_2 processing are "murder on metal." Even that old corrosive marauder, H_2SO_4 gets into the act.

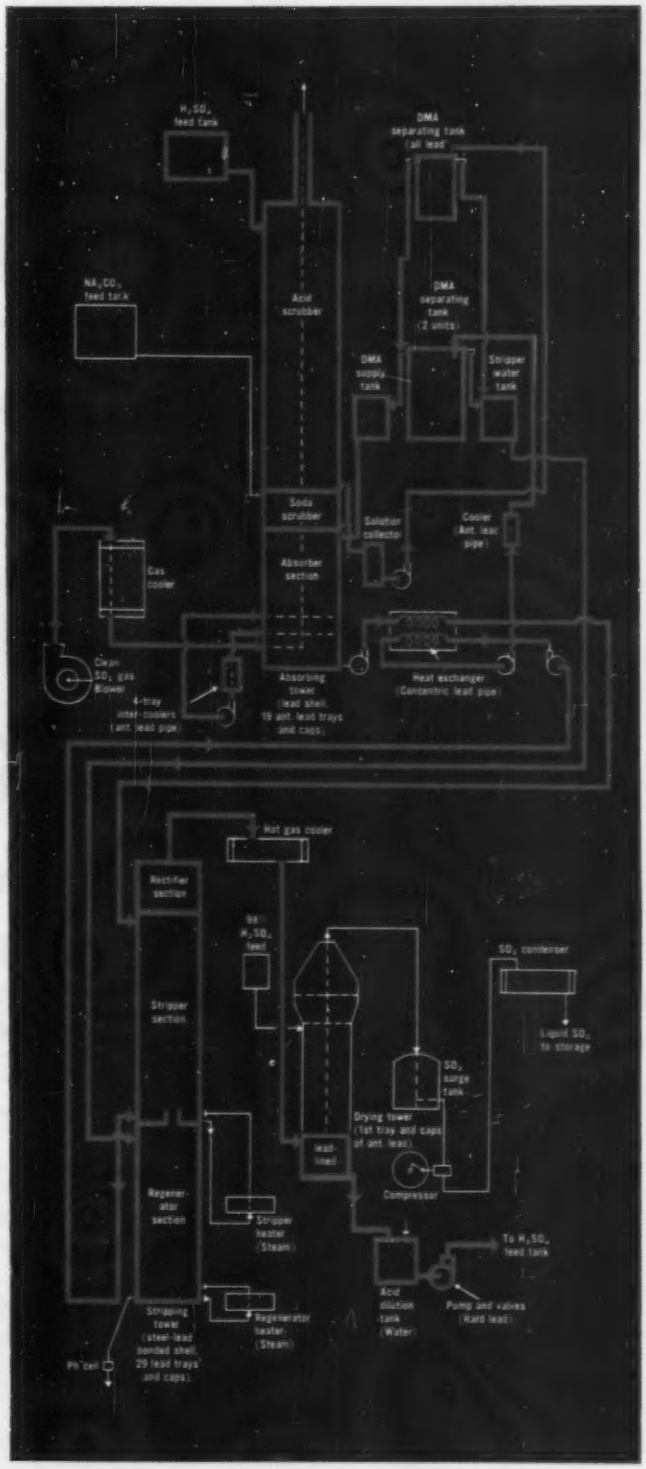
As a result, *lead* practically lives with these acids and gases throughout the SO_2 process. In fact, the flow chart at the right is almost a continuous flow of *lead* applications. For ducts. For piping. For sheet lead linings in the larger units like the scrubbers and strippers. It is used with steel, with wood, with copper and, in some cases, with concrete. The result is low maintenance cost, facility of repair and consequent freedom from costly production stoppages.

If your process involves corrosive chemicals, look to *lead* for *long life, low maintenance and minimum loss of production due to down-time.*

When you think of Lead ...*think of*

National Lead





National Lead has the experience to get *lead* and steel together in a *bond* that defies severe pressure and temperature changes, vibration and creep. That's been proved not only in regular production "stock" items such as piping and valves but also in specially designed, complex lead process and storage equipment.

If you are enlarging or modernizing your processing facilities, now's a good time to get the facts about lead-lined equipment. Contact National Lead Company, Lead Lined Products, 111 Broadway, New York 6, New York.

For more data on advertised products, use Readers' Service Cards, last page.

NEW BAILEY
Multi-Pointer Gage

...has twice as many indicators
...no taller than a telephone!

Now the popular versatile Bailey Multi-Pointer Gage has been reduced in size to conserve control panel space—without loss of easy *readability*.

Each new Multi-Pointer Gage Unit offers you these three choices to—

1. Measure and indicate draft, pressure, differential pressure and level.
2. Transmit above variables either pneumatically or electrically to remote indicators, recorders and/or controllers.
3. Receive and indicate any measured variables which may be transmitted pneumatically by standard SAMA ranges of 3-15 psig. or 3-27 psig.

FEATURES

Compact Size—Two large, easily-read 7″ scales in space only 4 inches wide.

Wide Range Selection—Standard ranges from 0-0.5 in. H_2O to 0-5000 psig available.

Choice of Standard Colors—Satin Black, Slate Gray, Moss Green, or Terra Tan may be selected as an exterior color at no additional cost.

Colored Scales—Scales available in white, red, green, blue, yellow, or orange.

Fluorescent Illumination—All gages have slideout unit containing bulb and starter for ease of maintenance.

Readily Accessible Adjustments—Zero adjustment made from front of gage. Other adjustments made from rear of gage.

Two-point Positive Mounting—Gage unit mounted with two clips . . . no holes to drill or studs to weld.

Unlimited Indications—Any number of basic two-indicator units may be placed side-by-side to provide indications of related factors. Each two-indicator unit is separately mounted.

For additional information, call your local Bailey District Office, or write us direct.

CP3-1

Chemical and petroleum division

BAILEY METER COMPANY

1043 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

BAILEY METERS

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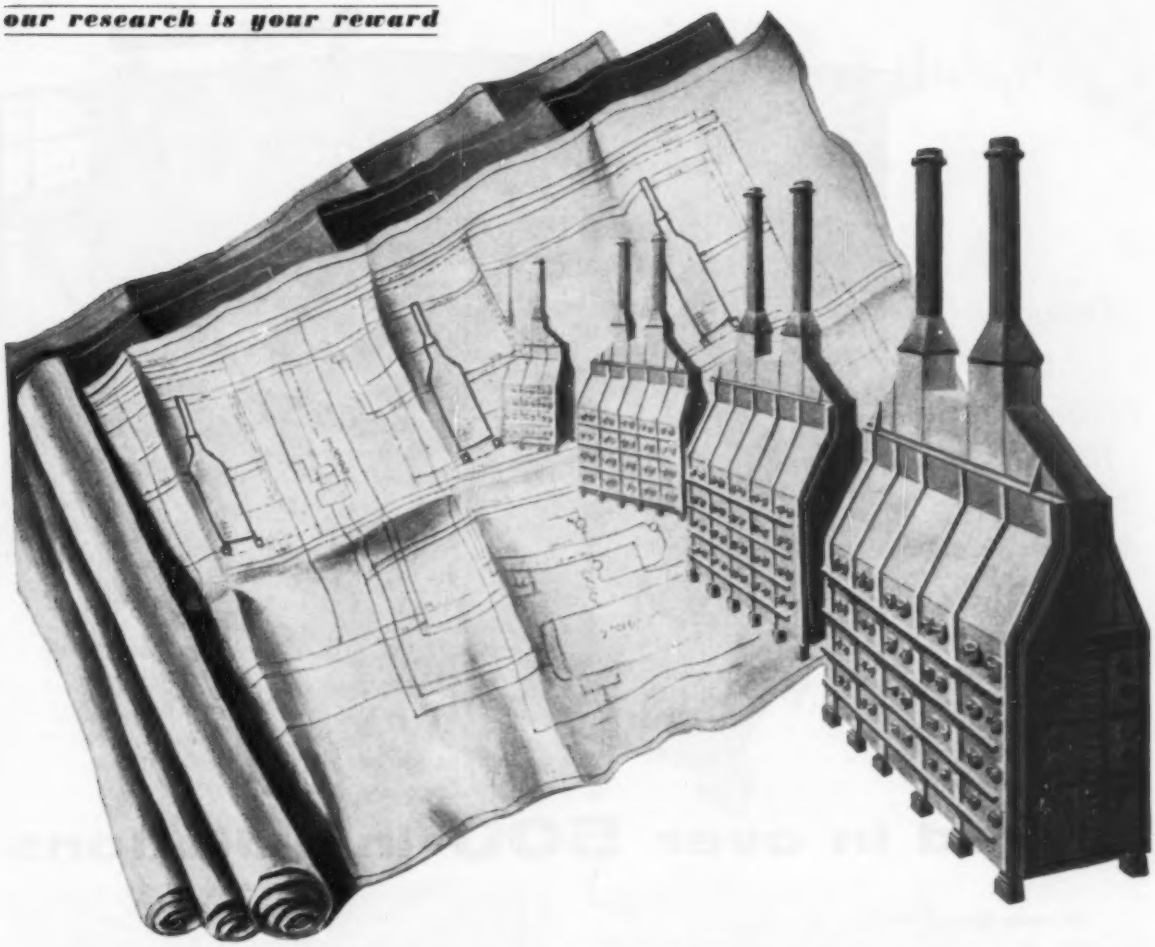
our research is your reward



73 Selas heaters in pyrolysis service demonstrate these extra benefits of Gradiation® processing

The difficulty in heat processing materials in conventional tubular heaters is to achieve uniform application of heat on the tube wall. Flame impingement or excessive heat on one side of the tube outer wall hastens metal degradation and, especially with highly corrosive feed stocks, tube corrosion.

Selas Gradiation overcomes that difficulty by distributing radiant heat uniformly along and around the entire tube wall, minimizing scaling and corrosion. Maximum allowable heat rate may thus be used in establishing coil length. The result: shorter lengths of tubes, fewer tubes, more compact furnaces. Obviously, tube replacement—when required—is less costly.

Selas heaters in pyrolysis service are designed to process a variety of feed stocks interchangeably. Burners are individually adjustable. Response to controller demands is split-second. This quality of Zone Control makes Selas heaters exceptionally versatile; makes them, as one processor has said: "The heart of the refinery."

Selas Gradiation heaters for the chemical, petrochemical and petroleum industries may be field-erected or shop-assembled. Selas also builds Econotherm* heaters for use where operations require materials to be heated to below decomposition temperatures.

Send for reprint "Try the Gradiation Heater for Economic Ethylene Production" and Bulletin 77 "Gradiation Heating for Petroleum and Chemical Processing." Selas engineers will be glad to discuss your heat-processing requirements with you. Selas Corporation of America, Dresher, Pa.

Gradiation is a registered trade name of Selas Corporation of America. * Trade Name

SELAS *Heat and Fluid Processing Engineers*

CORPORATION OF AMERICA
DRESHER, PENNSYLVANIA

DEVELOPMENT • DESIGN • CONSTRUCTION

For more data on advertised products, use Readers' Service Cards, last page.

Designed for the Petrochemical Industry

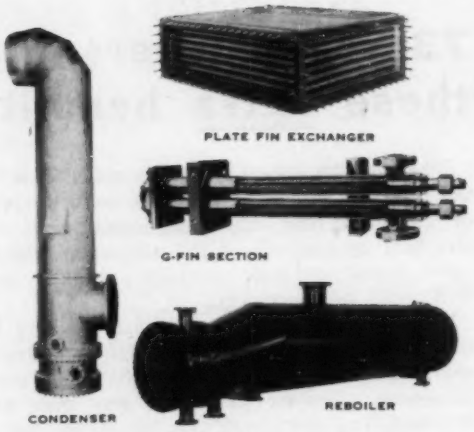
Proved in over 500 installations

Griscom-Russell fin-fans, by eliminating the cost of water, pumps, piping, valves, water treatment and maintenance, are the economical heat exchangers for many petrochemical cooling and condensing services.

G-R **fin-fans** are designed of the highest quality components to fit your special application. The transfer area is made of G-R's strong, helically finned tubing for highest efficiencies. Exceptional design and pre-fabricated construction minimize installation and maintenance expenses.

fin-fans are available in forced or induced draft designs with a wide range of capacities. Many accessories are available to solve special drive, control and weather problems.

Send for Griscom-Russell Bulletin 2400.



G-R Designed for the Petrochemical Field

Reboilers • G-Fin Sections • Condensers • Plate Fin Exchangers • Longitudinally and Helically Finned Tubing • Bentube Evaporators • Liquid Heaters • Tubular Heat Exchangers • Solution Heaters • Oil and Water Coolers • Tank Heaters • Gas Coolers • Bentube Sections

HEAT EXCHANGE EQUIPMENT FOR THE PETROCHEMICAL INDUSTRY

GR 380

Griscom-Russell

GENERAL PRECISION EQUIPMENT CORPORATION GPE

THE GRISCOM-RUSSELL COMPANY • MASSILLON, OHIO
A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

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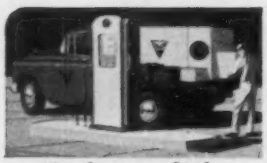
Four amazing advantages of Solar Gas Turbine Engines

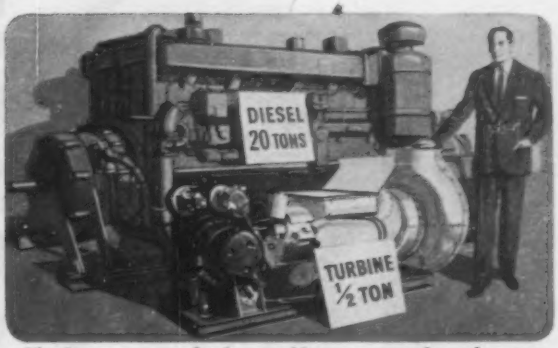


Gasoline—any kind.

Diesel oil

Kerosene.

Natural gas.



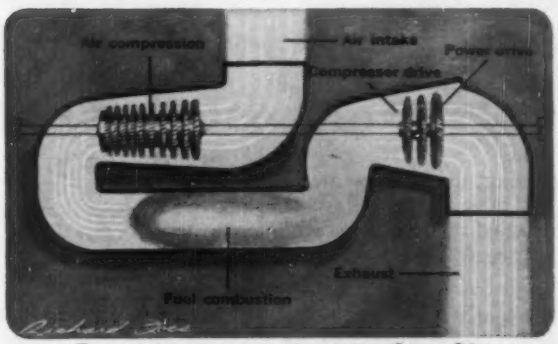
The Jupiter is completely portable—saves weight and space.

❶ Uses whatever fuel you've got!

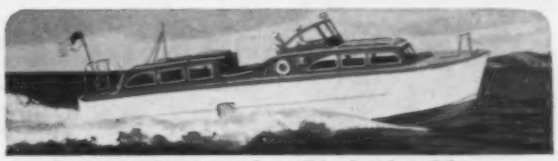
Solar gas turbines can operate on almost any available fuel—fuel that costs the least for *your* particular operation. Located in remote areas, for instance, self-sufficient Solar turbines can take fuel directly from a gas pipeline! This often results in lower total operating costs.

❷ Light—500 hp in 1/5 the space!

Solar's 500 hp Jupiter® engine is only one-fifth the size of a diesel of similar horsepower—and weighs *forty times less!* The entire unit is easily transported to remote locations. And it is especially suited to applications where space limitations create a troublesome installation problem.



Few moving parts, no reciprocation—longer life.



Instant acceleration—takes full load without laboring.

Instant emergency power.

Starts in any climate.

❸ Simple design—low maintenance!

Gas turbines are the simplest of all heat engines. In operation, large volumes of air are drawn in by the compressor, mixed with fuel in the combustion chamber, greatly expanded, and delivered to a turbine which produces shaft power. Routine servicing can be completed in a few hours at most. Overhauls are infrequent. Simple design and low maintenance make gas turbines ideal for a wide range of important applications—including boat propulsion, portable power generation, air compression and chemical processing. And other applications for these versatile power plants of the future are limited only by the imagination.

❹ Starts instantly—no warm-up!

Solar gas turbines can be turned on or shut down in seconds. And they require no warm-up—even after long periods of stand-by service. No matter what your business, no matter what your power needs, these amazing advantages can benefit you. Write to Dept. F-97 for free gas turbine brochure.

SOLAR
AIRCRAFT COMPANY
SAN DIEGO
DES MOINES

2200 PACIFIC HIGHWAY • SAN DIEGO 12, CALIFORNIA

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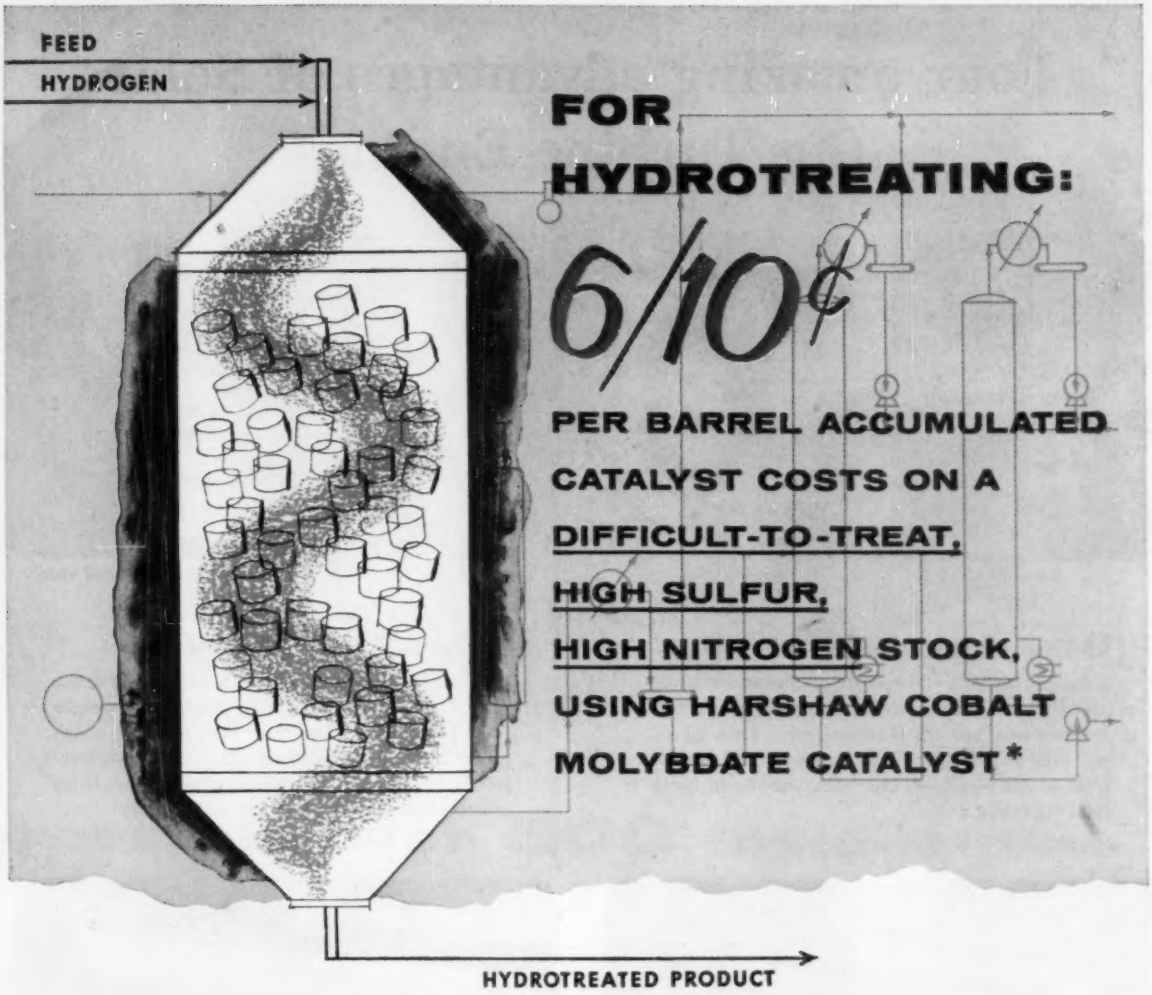

FOR HYDROTREATING:

6/10¢

PER BARREL ACCUMULATED CATALYST COSTS ON A DIFFICULT-TO-TREAT, HIGH SULFUR, HIGH NITROGEN STOCK, USING HARSHAW COBALT MOLYBDATE CATALYST*

Consistently low catalyst costs for hydrotreating, using Harshaw Cobalt Molybdate Catalyst, are possible because the inherent ruggedness and high thermal stability of our catalyst permits repeated regenerations while maintaining full activity—in one instance *223* regeneration cycles without loss in activity.

This versatile Harshaw catalyst performs efficiently over a wide range of feedstocks—from low boiling naphthas to heavy coker distillates. In all applications, the long life of our catalyst reflects reduced per-barrel costs.

For further information contact the Harshaw Branch nearest you. Our representative will be happy to discuss with you the application of Harshaw Cobalt Molybdate Catalyst to your operation.

*Based on an actual customer experience to date in a specific unit still operating. Its continuing operation will further reduce the 6/10¢ per barrel cost.

HARSHAW

THE HARSHAW CHEMICAL CO.

1945 E. 97th STREET • CLEVELAND 6, OHIO

CHICAGO
CINCINNATI
CLEVELAND
DETROIT
HASTINGS-ON-HUDSON
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PHILADELPHIA
PITTSBURGH

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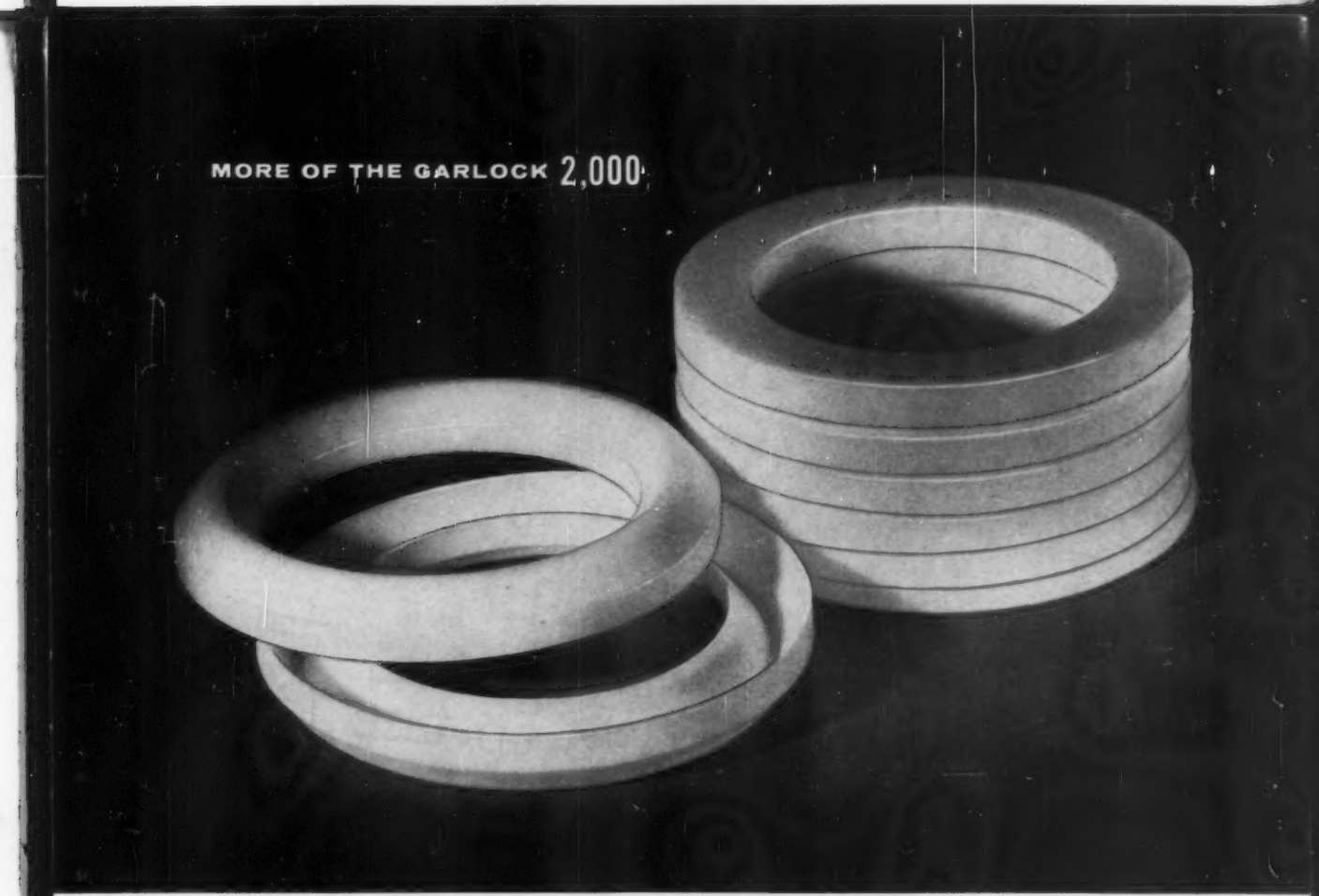


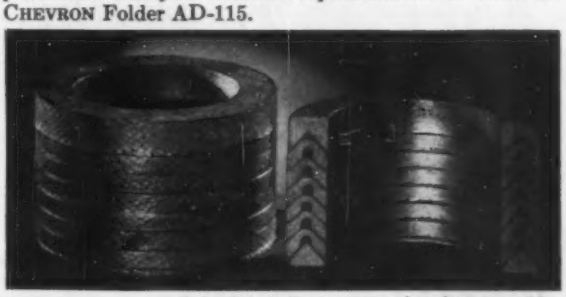
GARLOCK CHEVRON* Packings Seal Positively, Resist Corrosion from –110° to +500°F

Designed specifically for the countless reciprocating pump and valve stem applications in petro-chemical plants, Garlock CHEVRON packings made with TEFLON**, Kel-F***, or Viton** do a better job of positive sealing—with less down-time and maintenance—for two reasons:

1. CHEVRON construction. Using an exclusive hinge-like design, CHEVRON packings permit free operation with minimum friction at all pressures. As pressure increases, the packing rings tighten to prevent leakage; as it declines, the rings ease off to permit free movement of the rod, ram, or piston. This means that, once initial adjustment of the gland is made, no further regulation is necessary to compensate for pressure variation.

2. Chemically-inert Teflon, Kel-F, or Viton. Made of chemically-inert Teflon or Kel-F, CHEVRON packings have a very low coefficient of friction, and can be kept in continuous service at temperatures from −110° to +500°F with good conformability. Made of Viton, CHEVRON resists most solvents and acids to 600°F without loss of physical characteristics.

Garlock CHEVRON packings made with Teflon (Style 8764 shown above) are recommended for chemical processing where contamination and decay are the main problems. On less corrosive applications, Garlock CHEVRON packings of cotton duck and oil-resistant neoprene (illustrated below) are suggested. CHEVRON packings with Teflon are part of the Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals for every need. The only complete line. Call your Garlock representative or write for CHEVRON Folder AD-115.



Style 431 CHEVRON assures low friction, positive seal, lasts longer than ordinary V-type packings, and works efficiently in shallow stuffing boxes.

*Garlock trademark **Du Pont trademark
***Registered trademark, 3M Company

THE GARLOCK PACKING COMPANY, Palmyra, N. Y.
FOR PROMPT SERVICE, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Molded and Extruded Rubber, Plastic Products

This Policy insures
the life of
Cooling Towers
against the hazard of
FUNGAL DECAY
Prolongs Life of
Cooling towers in all parts of the country were inspected for visible evidence of fungus attack. Wood
with Marley for MARTREAT wood preservative application are those with the manpower, facilities and
resources to thoroughly investigate and evaluate the
cooling towers. (Little considered prior to that date, a

NEW FREE BOOKLET tells how to add YEARS to the life of your COOLING TOWER... at low cost!

Marley's exclusive MARTREAT® process is the *proven* way to halt fungal decay and add years to the life of your water cooling tower—and it can be economically applied to any cooling tower now in service, regardless of age or make.

A new informative Martreat Bulletin sums up Marley's years of leadership and experience in preservative wood treatment for cooling towers—pinpoints the organisms that destroy the effective performance of your tower and eat away your investment . . . prescribes the treatment that arrests these destructive organisms, and its application techniques . . . demonstrates the efficacy of the Martreat process . . . documents industry's wholehearted acceptance of this unique wood preservative treatment.

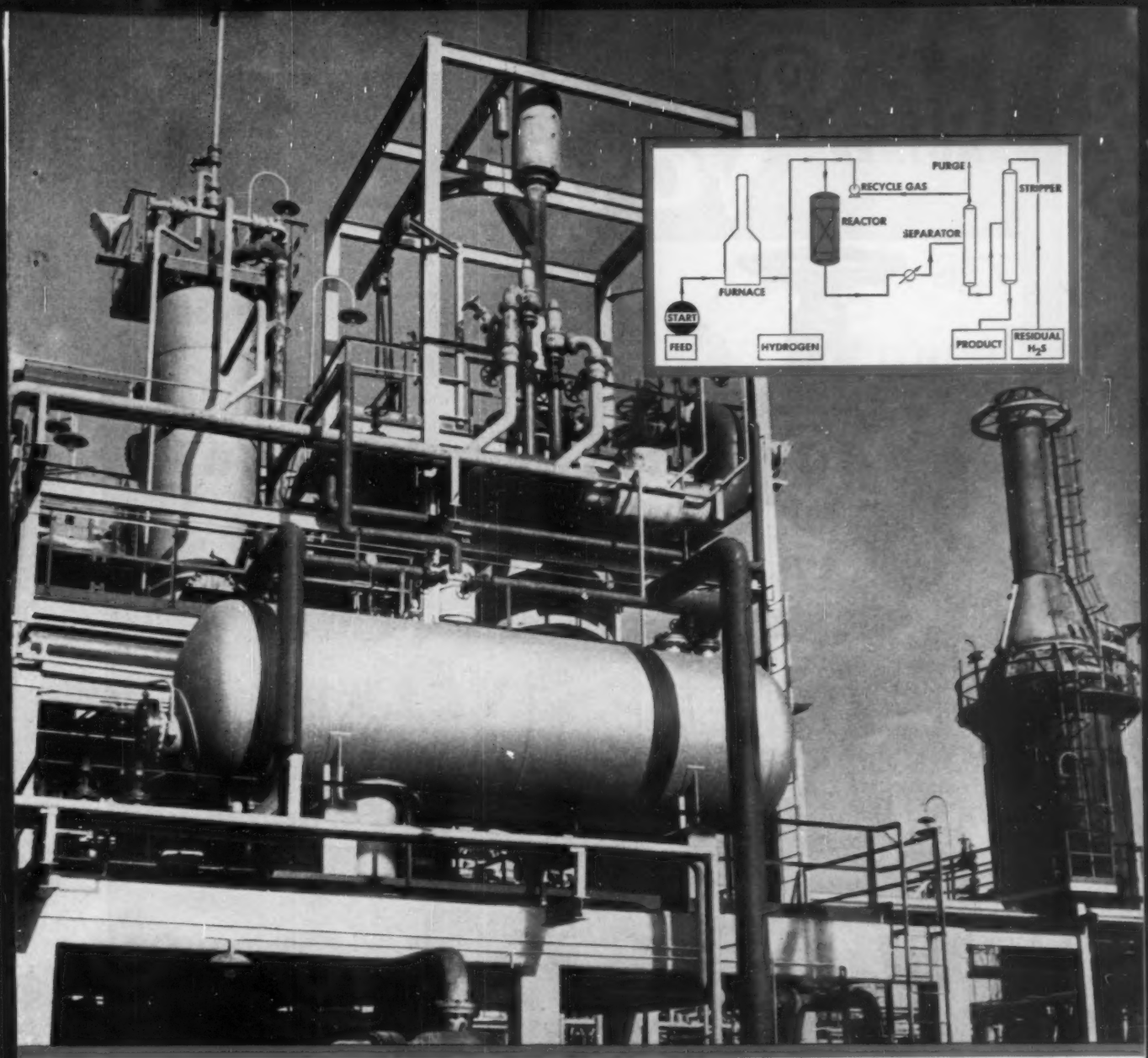
Only Marley can offer you this form of "cooling tower life insurance" backed by successful treatment of more than four million board feet of cooling tower lumber for the country's largest industrial organizations (name list available) in the petroleum, power, chemical and food processing industries. Write today or ask your Marley representative in any of 56 cities for the new MARTREAT BULLETIN MT-58.

Also available—descriptive folder on Marley's complete engineered reconstruction services

MARLEY

The Marley Company

Kansas City, Missouri



19,500 B/D CRACKED HEATING OIL HYDROFINER, ESSO STANDARD'S BAYWAY REFINERY, LINDEN, N. J.

HYDROFINING CAN GIVE YOU TOP PERFORMANCE AT LOWEST INVESTMENT

Esso Research and Engineering offers you *Hydrofining*, a process now being applied to a greater variety of feed than any other hydrogen-treating process. *Hydrofining* uses by-product hydrogen to remove sulfur and other impurities *without yield loss*.

The process improves product stability, odor, color and other quality characteristics without the disadvantages of chemical or clay treating methods. *Hydrofining* is another achievement of the Esso Research program — 39 years of new process developments made available to refiners around the world.

Hydrofining experience has been gained from commercial units processing a wide variety of feed stocks such as naphthas, distillate fuels, lubes and waxes. This experience plus years of hydrogenation research gives us a unique opportunity to recommend the best design for your plant.

Twenty-three *Hydrofining* installations are on stream; nineteen more are in the construction or planning stage. Licensees enjoy benefits of continuing *Hydrofining* research. *Hydrofining* can play an important part in helping you process previously unattractive stocks into higher quality products. We would welcome your inquiry.

ESSO RESEARCH AND ENGINEERING COMPANY

P.O. Box 243, Elizabeth B, N. J.

Your key to progress... an Esso Research process

ANOTHER **Vogt** FIRST

9 NEW FLANGED END FORGED STEEL

GENERAL GP PURPOSE

Gate, Globe and Check VALVES

with

HARD FACED SEATS
150, 300 and 600 ASA STANDARD

featuring:

ASA Standard flanges and face-to-face dimensions
*Stellite hard faced seats and hardened wedges and discs
Spiral wound body-bonnet gaskets
Stainless steel gland studs and nuts
Interchangeable parts
Light weight with maximum strength
Complete line—pressures, sizes and types

*Union Carbide Corp.

Write for Literature. Address Dept. 24A-FPR.

Vogt GENERAL GP PURPOSE Vogt FOR BETTER VALVES

HENRY VOGT MACHINE CO., BOX 1918, LOUISVILLE 1, KY.
SALES OFFICES: New York, Chicago, Cleveland, Dallas, Camden, N. J.
St. Louis, Charleston, W. Va., Cincinnati

FORGED STEEL VALVES

For more data on advertised products, use Readers' Service Cards, last page.

Tailor-made, tough and chemically inert...

. . . these J-M Chempac Teflon components combat chemical and solvent action!*

SMALL OR LARGE . . . intricate or simple . . . J-M Chempac® Teflon components have proved their exceptional resistance to the constant attack of corrosive chemicals in rugged service.

Look to J-M for Teflon packings, gaskets, and moulded shapes made to your exact specifications . . . or for parts that are machined to close dimensional tolerances. Moreover, we can combine Teflon with top quality J-M asbestos to impart the exceptional sealing and heat-resistance properties of the "magic mineral." And in addition to corrosion-resistance, Teflon gives you the advantages of an extremely low coefficient of friction . . . toughness and flexibility . . . and weight-saving possibilities.

You can also obtain J-M Chempac Teflon Packings in moulded and braided types for pumps and valves . . . in a wide range of flange and envelope-type gaskets . . . in rings, cups, sheets and tapes. Your J-M Packings Distributor can supply your needs. Or write Johns-Manville, Box 14, New York 16, New York. In Canada: Port Credit, Ontario.

*TM for DuPont Tetrafluorethylene resin.

Teflon rods, tubes, tapes and sheets —in addition to components of varied sizes and shapes as indicated here—are also available from Johns-Manville. Prompt delivery of any quantity you need is assured by new J-M production facilities.

JOHNS-MANVILLE JM PRODUCTS

JOHNS-MANVILLE

100 YEARS OF QUALITY PRODUCTS . . . 1858-1958

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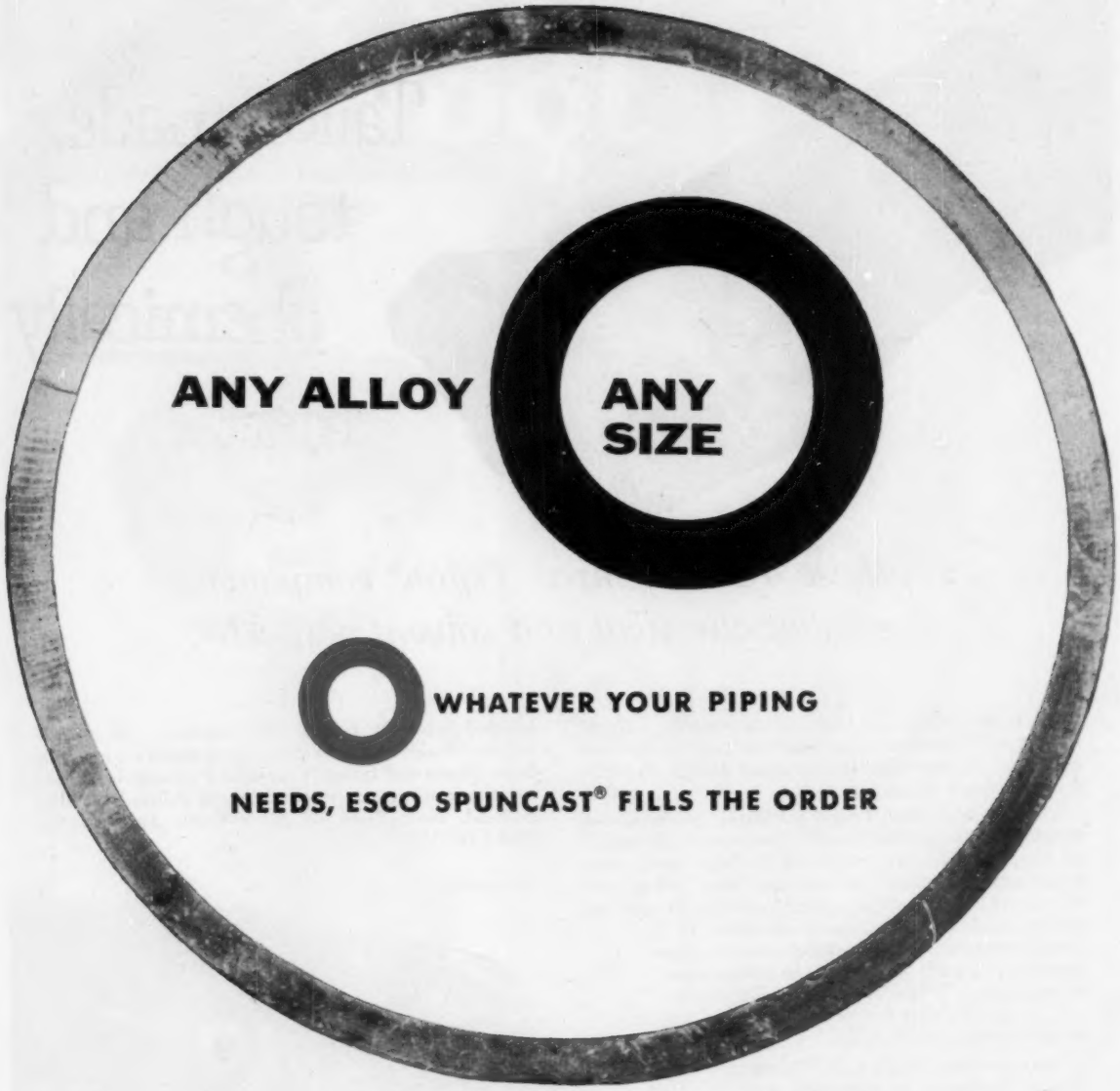

Corrosion, heat, abrasion or vibration, you can reduce them all with *ESCO* Spuncast pipe. Centrifugally cast in a wide variety of *ESCO* alloy steels, heat treated and tested, *ESCO* Spuncast pipe will cut replacement costs in chemical, pulp and paper and petro-chemical plants, or in any other type of installation subject to severe conditions.

Available in special alloys, in sizes to 36" OD and wall thickness from ¼" up and in large or small quantities *ESCO* Spuncast Pipe is the greatest corrosion-resistant value your pipe dollars can buy.

Write for free booklet—"How to Cut Costs With ESCO Spuncast"

ESCO

ELECTRIC STEEL FOUNDRY COMPANY

2164 N. W. 25TH AVE. • PORTLAND 10, OREGON
MFG. PLANTS AT PORTLAND, ORE. AND DANVILLE, ILL.
Offices in Most Principal Cities
ESCO INTERNATIONAL, NEW YORK, N. Y.
IN CANADA ESCO LIMITED

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1000 BRINELL DURACASE TRIM...

Stops galling and erosion

Since the introduction of OIC's Duracase Trim, many forged steel valve specs are obsolete. This 13% chrome stainless steel trim with 1000 Brinell, case-hardened wedges and discs assures positive protection against even the simultaneous attack of the three valve-destroying agents—corrosion, erosion, galling.

OIC offers you a choice of two modern body-bonnet connections—union ring or bolted bonnet—on its entire forged steel gate, globe, angle, and check valve line.

In addition, gate valves offer a choice of standard-flow or high-flow body ports, both with 1000 Brinell wedges.

Step up your valve requirements to the modern high-quality standards reflected in OIC valves. Include OIC on your next specification.

For OIC forged steel valve specification literature, write for Forms No. 195 and 195-R.

THE OHIO INJECTOR COMPANY • WADSWORTH, OHIO

OIC VALVES | FORGED & CAST STEEL, BRONZE & IRON VALVES

For more data on advertised products, use Readers' Service Cards, last page.

The delicate ingredients in milady's cologne take more than garden-variety metering—as do the critical ingredients in chemical and food processing, gas odorizing and water treatment.

Accurate, dependable metering assures product quality and uniformity. Hills–McCanna metering and proportioning pumps assure precise metering at low cost. Do as the leaders in industry do—"look to the people who know and control flow."

WRITE TODAY *for a copy of our new booklet, "Precision Proportioning Pumps" which explains Hills-McCanna's complete line of pumps.*

HILLS-McCANNA COMPANY
4614 West Touhy Avenue • Chicago 46, Illinois

hills-mccanna company
THE PEOPLE WHO KNOW AND CONTROL FLOW

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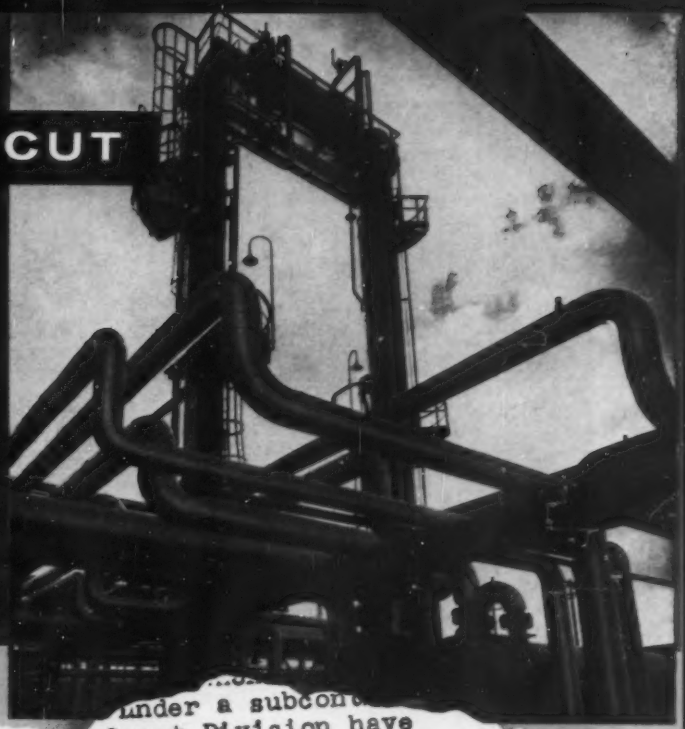
NOT ONE FIELD CUT

in all This

MIDWEST

Shop-Fabricated Piping



...nder a subcon...
and I would like to say the West Coast Division have on this job complied fully with the high standards of workmanship for which Midwest is known.

Throughout this entire project not once was a cut necessary to correct any piece of fabrication, and I might add in several instances close tolerances had to be met.

The above was not written on an impulse but as construction superintendent, this means but one thing: fast and low cost erection. Would appreciate your thanking Midwest personally for ...om a construction

Excerpt from letter by:
HOLMES & NARVER • Engineers-Constructors
828 South Figueroa St. • Los Angeles 17

Note particularly the words "*fast and low cost erection*" in the above letter. They characterize Midwest Shop-Fabricated Piping . . . whether for refinery, power plant or industrial installations. In this instance they were written by A. H. Chamberlain, construction superintendent, upon completing the installation of a Houdriformer Unit at the U.S. Oil & Refining Co., Tacoma, Washington.

There are three well-equipped Midwest pipe fabricating shops located to serve economically all sections of the country. Each is staffed by a highly skilled organization using the latest techniques. Each has wide experience on all kinds of projects so that the possibilities and limitations of all piping materials are well understood. You too will find it to your advantage to call in Midwest whenever you need fabricated piping.

MIDWEST PIPING COMPANY, INC.

Main Office: St. Louis 3, Missouri (P.O. Box 433)
Plants: St. Louis, Clifton, N.J. and Los Angeles

SALES OFFICES:

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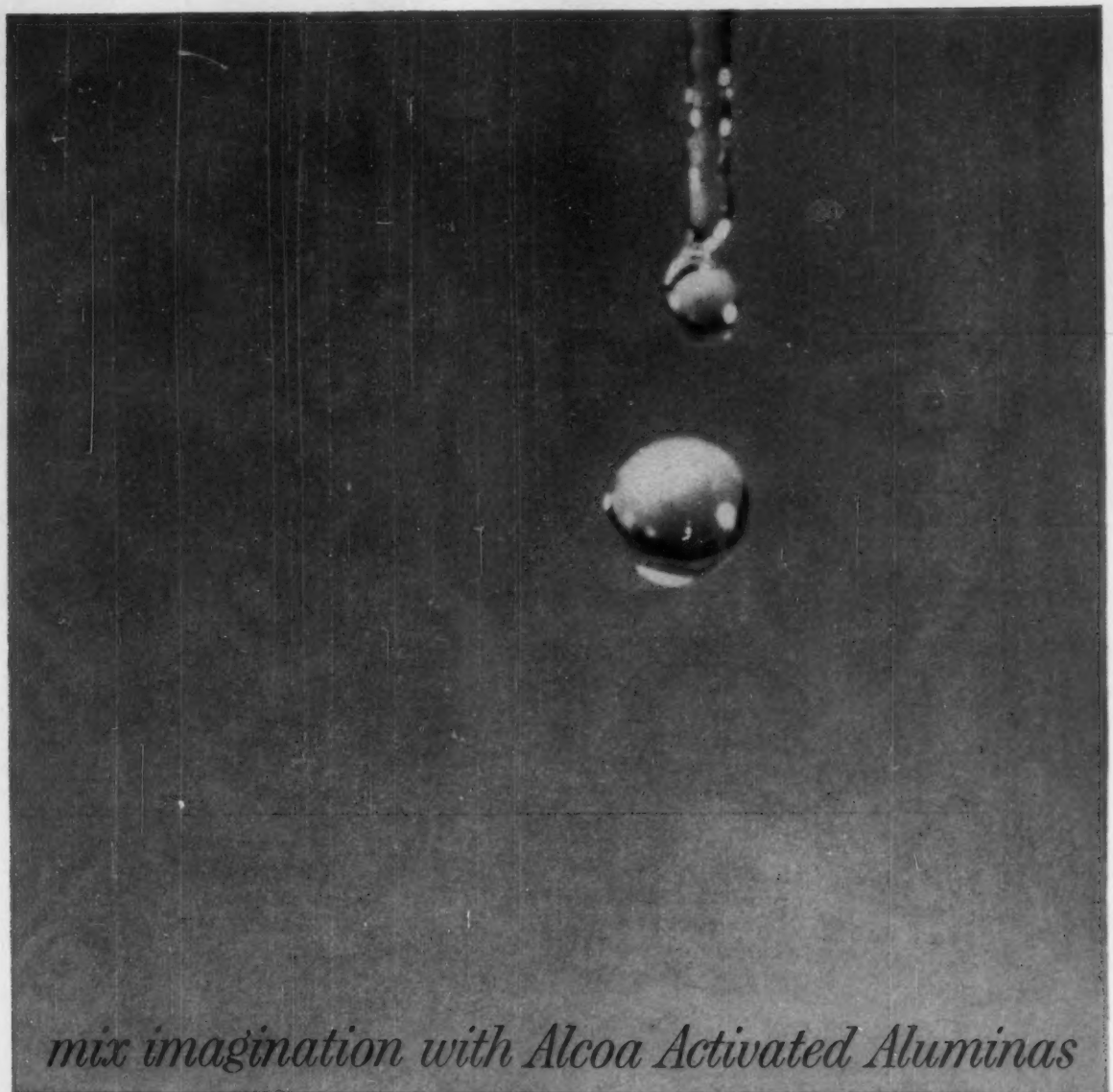
8033

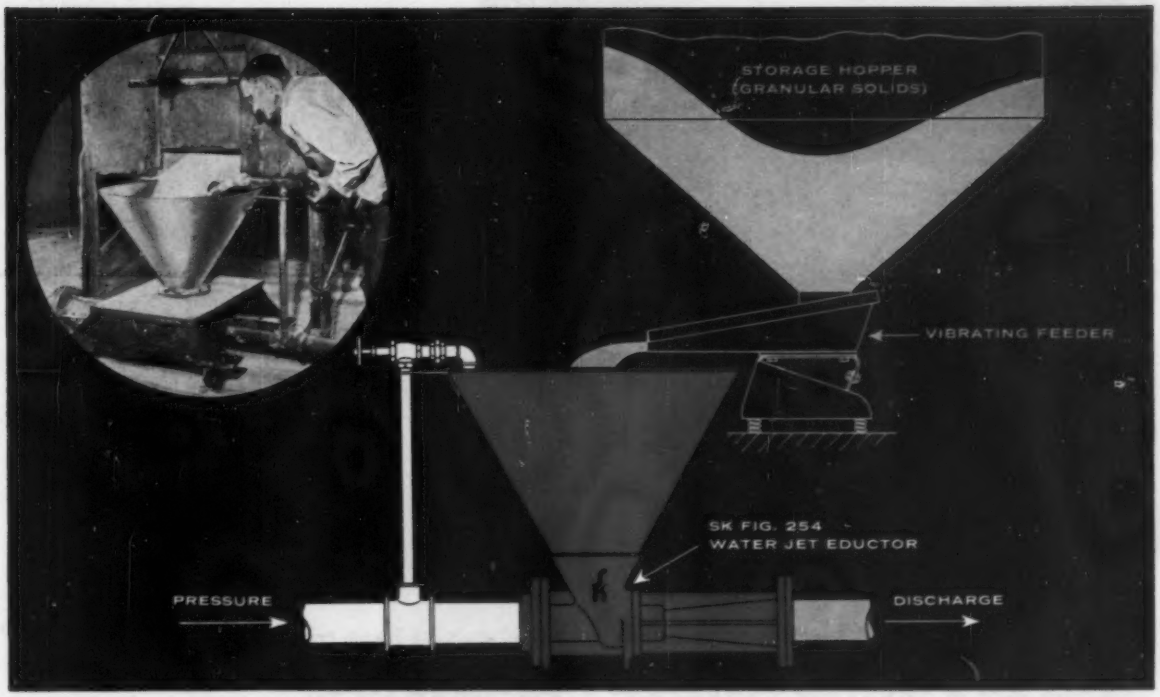


to remove the last drop of unwanted product or process water. Is unwanted water undermining your product quality . . . or ruining the efficiency of your process? If so, try this sure solution to your dehydration problems: mix imagination and engineering with Alcoa® Activated Alumina. You can count on this old reliable among commercial desiccants to achieve the lowest dew points you require. It can never soften, swell or disintegrate. It is nontoxic, noncorrosive and practically iron-free. It can be saturated and reactivated through almost endless cycles—to keep drying costs low. Put the proved effectiveness of Alcoa Activated Alumina to work in solving *your* dehydration problems. Drying machines charged with Alcoa Activated Aluminas are available from a number of manufacturers. For their names, or for product information, contact your local Alcoa sales office. Or write ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 717-M Alcoa Building, Pittsburgh 19, Pa.

For finer products . . . let Alcoa add new dimension to your creative thinking!

ALCOA CHEMICALS

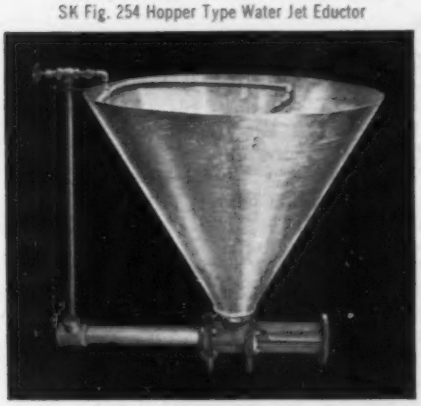
ALCOA THEATRE
Fine Entertainment
ALTERNATE MONDAY EVENINGS



MIX SOLIDS WITH LIQUID, CONVEY SLURRIES

with this SK "Hopper Type" Water Jet Eductor

SK Fig. 254 Hopper Type Water Jet Eductor



SK's Hopper Type Eductor, shown above and at left, will mix solids with liquid and convey slurries conveniently and at low cost. See box below for types of granular solids currently being handled.

An inexpensive unit, this light-weight eductor is easy to install, simple in construction with no moving parts, requires little maintenance, and provides efficient service over long periods. In operation, pressure water, issuing through the nozzle, entrains granular solids from the hopper and discharges through discharge piping. Agitating jets keep material moving down into the eductor.

Used in the petroleum industry, in chemical processing and food processing plants, the hopper eductor has proved to be extremely satisfactory in handling the materials (bulk densities noted) listed below and others.

For full details on Hopper Type Eductors including sizes, capacities, ratios, water consumption, materials of construction, write to SK for Bulletin 2M.

SK HOPPER EDUCTORS ARE BEING USED CURRENTLY TO HANDLE THE FOLLOWING MATERIALS *(Approx. Bulk Densities Indicated in Parentheses)*

Borax (50-55)
Charcoal (18-28)
Diatomaceous Earth (10-20)
Lime, Pebble (56)
Lime, Powdered (32-40)
Mash (60-65)
Fly Ash (35-40)
Rosin (67)
Salt, Granulated (45-51)
Salt, Rock (70-80)
Sand, Damp (75-85)
Sand, Dry (90-100)
Sawdust, Dry (13)
Soda Ash, Light (20-35)
Sodium Nitrate, Dry (80)
Sulphur, Powdered (50-60)
Wheat (48)
Zinc Oxide, Powder, Dry (10-35)

JET APPARATUS: Ask for Condensed Bulletin J-1.
ROTAMETERS & FLOW INDICATORS: Ask for Condensed Bulletin M-1.
VALVES: Ask for Condensed Bulletin V-1.
HEAT TRANSFER APPARATUS: Ask for Condensed Bulletin HT-1.
GEAR PUMPS: Ask for Bulletin 17-A.

Schutte and Koerting
COMPANY
MANUFACTURING ENGINEERS SINCE 1876
2257 State Road, Cornwells Heights, Bucks County, Pa.

For more data on advertised products, use Readers' Service Cards, last page.

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- ___BROWN-SHARPE—Precision Tools
- ___CHICAGO-LATROBE—Drill Bits
- ___DELTA—Industrial Equipment
- ___DEVCON—Plastic Steel
- ___HELLER—Files
- ___INGERSOLL-RAND—Pumps, Compressors
- ___J & B—Shelving
- ___KEUFFEL & ESSER—Measuring Tapes
- ___KRAEUTER—Mechanics Tools
- ___LECTROLITE—Wrenches
- ___LYONS—Lockers, Steel Equip.
- ___MILLERS-FALLS—Hand Tools
- ___MILWAUKEE—Ind. Elec. Tools
- ___MUNDET—Insulations
- ___NATIONAL CYLINDER GAS—Welding Equip.
- ___PERMA-GLAS MESH—Glass Fabric
- ___PITTSBURGH CORNING—"Foamglas" Insul.
- ___PROTO—Mechanics Tools
- ___RED DEVIL—Glazier's Tools
- ___REPUBLIC—Flex-Angle Shelving
- ___RIDGID—Pipe Wrenches
- ___RUSTOLEUM—Rust Preventatives
- ___SANDS—Levels
- ___SANDVIK—Saws
- ___SHERMAN-KLOVE—Mechanics Tools
- ___SKIL—Electric Tools
- ___SUPREME—Versamatics
- ___TALCOTE—Weathercoatings
- ___THERMON—Heat Transfer Plastic
- ___TOLERTON—Work Benches
- ___UNION ASBESTOS—"Unibestos" Insulation
- ___UNION STEEL—Tool Chests
- ___VAUGHN-BUSHNELL—Hammers
- ___WELLER—Soldering Guns
- ___WESTINGHOUSE—Motors
- ___WOODALL—Pegboard

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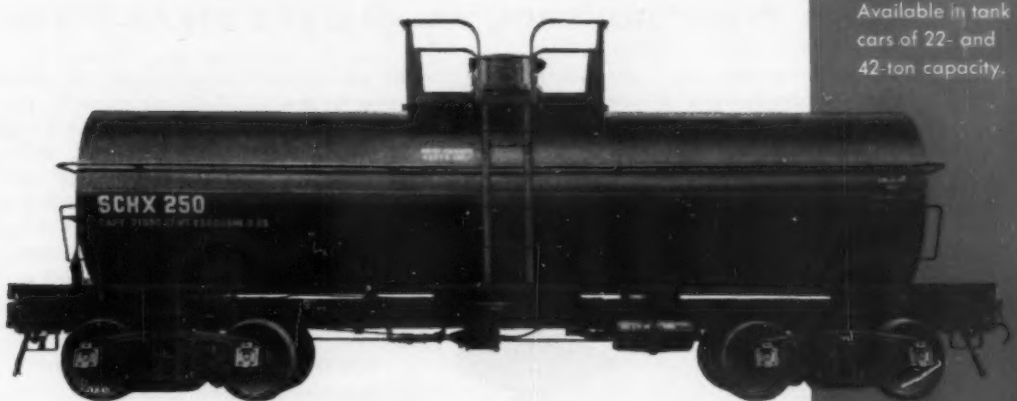
HYDROFLUORIC ACID

anhydrous and aqueous

STAUFFER HAS IT...

IN QUANTITY AND QUALITY



Available in tank cars of 22- and 42-ton capacity.

Stauffer CHEMICALS SINCE 1885

STAUFFER CHEMICAL COMPANY

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Prudential Plaza, Chicago 1, Ill. • 636 California Street, San Francisco 8, Calif.

NYOTEX CHEMICAL DIVISION, P.O. Box 9716, Houston 15, Tex.

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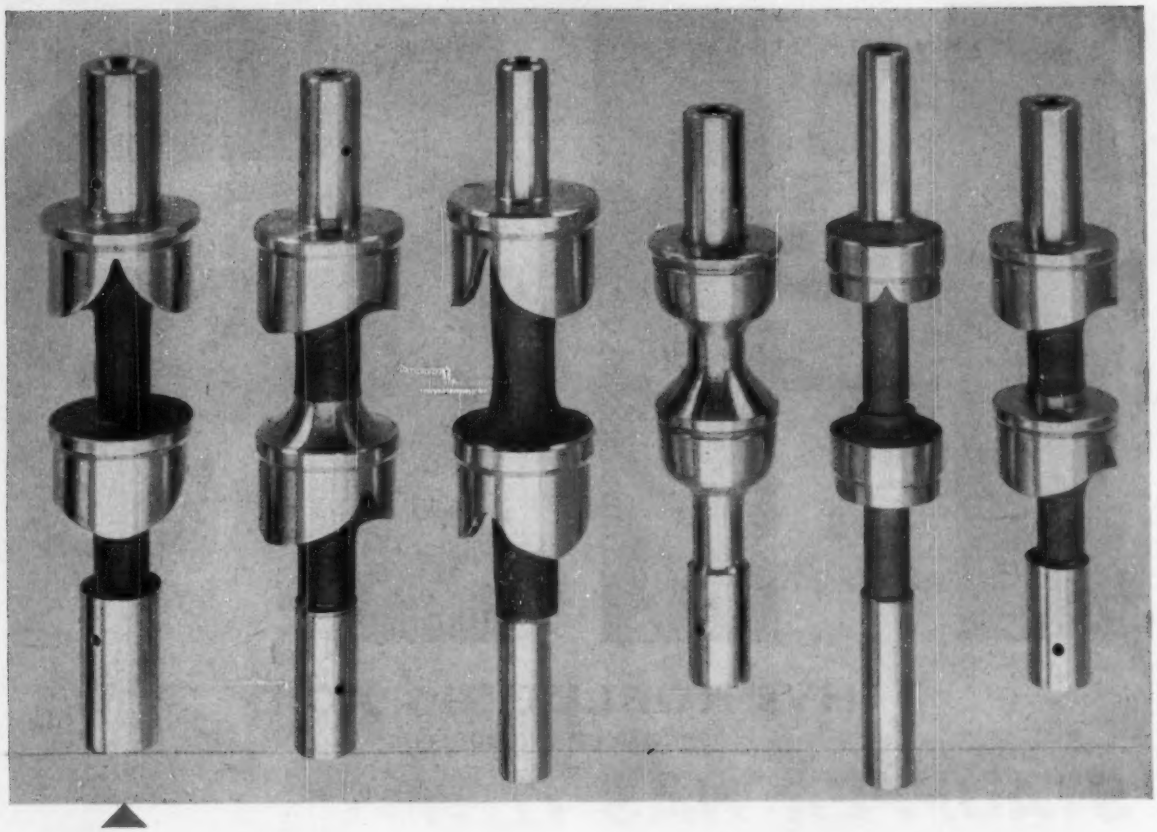


Inner secrets of inner valves

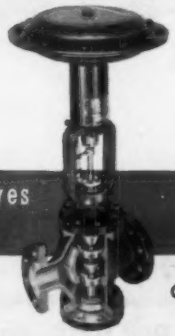
FACTS EVERY CONTROL VALVE USER SHOULD KNOW

This is a rare photograph . . . presented in a completely unretouched form. It shows the inner valve of leading makes of diaphragm control valves. The inner valve determines the control result.

The most amazing fact is the size . . . all are *listed* as two inch valves. All are high lift. But compare them.

Note the KIELEY & MUELLER inner valve at the far left. It equals the others on every point of consideration; exceeds on many. Look at the diameter across the skirt . . . that's one reason for the remarkable C_v of K&M valves. Look at skirt length; the solid, not fabricated, design. Measure the rugged guide posts and the large column. Examine the machining and the super-finishing.

It's no wonder . . . K&M is *the valve that likes to be compared*. It's a better valve and a better value by every measure of comparison.



FOR THE COMPLETE FACTS . . . write for the K&M Valve Engineering Data Catalog, Bulletin CV53.

diaphragm control valves

KIELEY & MUELLER, INCORPORATED

K&M

Our 78th Year

Oldest Pressure and Level Control Valve Manufacturer

64 Genung Street, Middletown, New York

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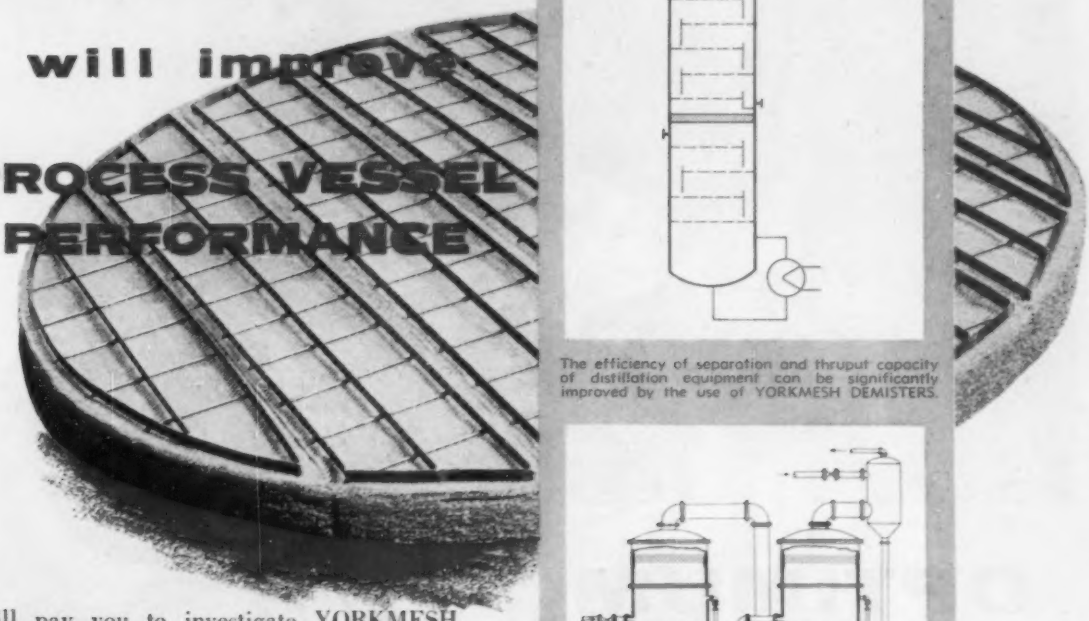
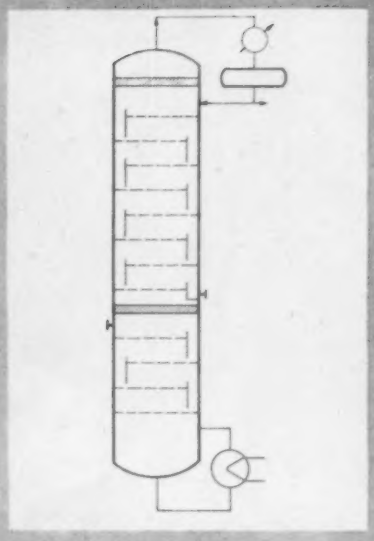
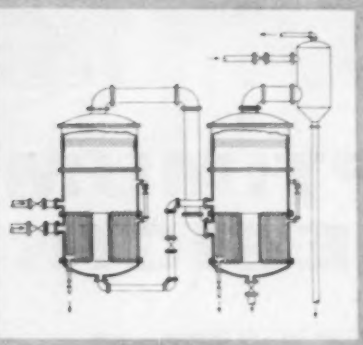
YORKMESH® DEMISTERS

will improve PROCESS VESSEL PERFORMANCE

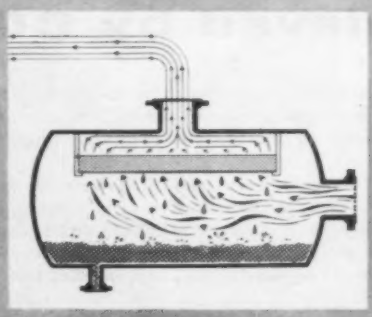




The efficiency of separation and thruput capacity of distillation equipment can be significantly improved by the use of YORKMESH DEMISTERS.



YORKMESH DEMISTERS installed in evaporators avoid product loss and provide clean condensate.



YORKMESH DEMISTERS installed in Knock-Out Drums result in high separation efficiency at low pressure drop.

It will pay you to investigate YORKMESH DEMISTERS if your process vessels need a lift in efficiency. The versatile knitted wire-mesh pads are being used more and more throughout industry to *stop* liquid entrainment and improve the performance of:

Vacuum Towers, Distillation Equipment, Gas Absorbers, Scrubbers, Evaporators, Knock-Out Drums, Steam Drums and many others.

Here is what happens when YORKMESH DEMISTERS are installed:

1. As vapor disengages from liquid it carries with it fine liquid droplets.
2. When the vapor stream passes thru the fine wire mesh, the liquid droplets impinge on the wire surfaces, coalesce in to large drops, and fall.
3. The vapor is now dry and free from entrained liquid.

Send us details on your type of process vessel or operation, vapor flow rate, pressure, temperature, and density or molecular weight; approximate amount of entrained liquid, viscosity, and specific gravity . . . for existing equipment advise dimensions, indicate vertical or horizontal vessel and material of construction required for mesh and grids. Complete details will make it possible for us to present our recommendations and quotation.

YORK

OTTO H. YORK CO., INC.

6 CENTRAL AVE. • WEST ORANGE, N. J.

For more data on advertised products, use Readers' Service Cards, last page.

OPTIMUM DESIGN...

of YUBA HEAT EXCHANGERS achieved by COMPUTER SYSTEM

Into Yuba's Central Computer System go the temperatures and pressures your heat exchangers must handle, flow quantities and fluid properties, tube layout, allowable pressure drop, and nozzle connections.

Out comes the number in series, shell size, minimum number of segmental baffles, optimum number of tube passes, calculated pressure drop, heat transfer rate on both shell and tube sides, and the corrected LMTD. Elapsed time: 15-20 minutes with the computer as compared to days with the slide rule.

No guesswork! Optimum results with absolute accuracy. Also...we can extract from the Yuba Computer System all kinds of alternates for you: alternate flow quantities, alternate temperatures, and alternate tube construction (fin or bare). This central computer system is used by all Yuba divisions manufacturing heat exchangers.

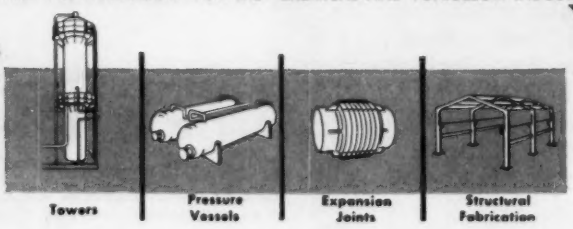
YUBA HEAT TRANSFER DIVISION, Honesdale, Pa.; ADSCO DIVISION, Buffalo, N. Y., and YUBA MANUFACTURING DIVISION, Benicia, Calif.

YUBA CONSOLIDATED INDUSTRIES, INC.

OTHER YUBA PRODUCTS FOR THE CHEMICAL AND PETROLEUM INDUSTRIES.

YUBA

Plants and Sales Offices



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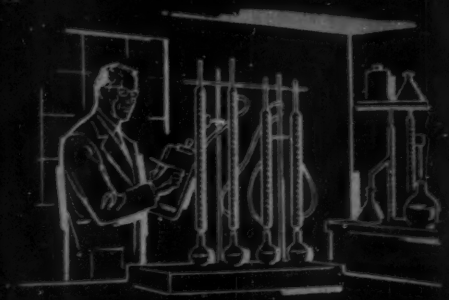
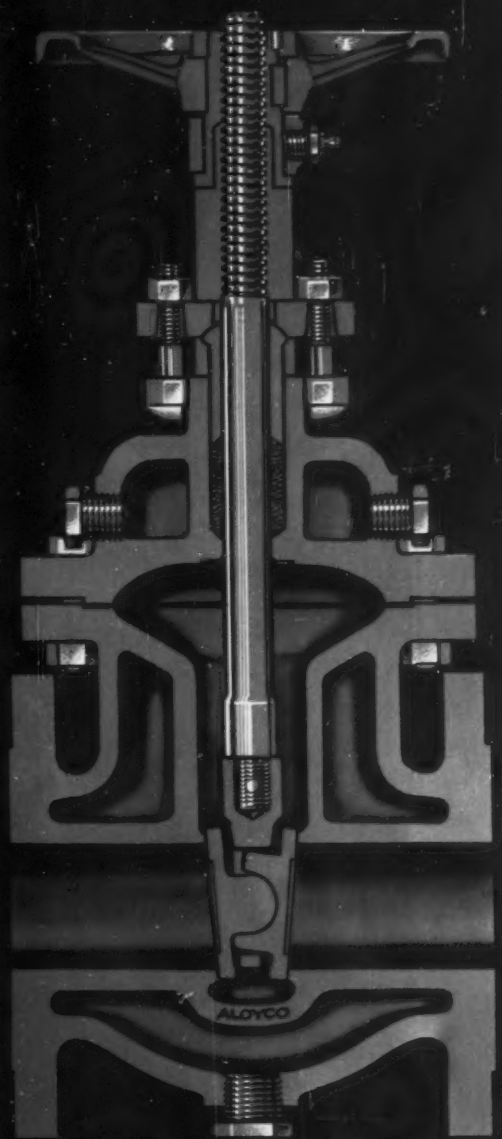




Thirty years' research devoted exclusively to...

STAINLESS STEEL VALVES

Aloyco's specialized research . . . in the field and in the lab . . . brings you a wealth of metallurgical information for successfully solving your corrosives-handling problems.

Coupled with continuing research in design, foundry and machining techniques, this Aloyco specialization results in new and better corrosion resistant valves for many specific applications. One example above: Aloyco completely jacketed valves (the first ever to be integrally cast in high alloys) are designed for viscous liquids and other fluids difficult to move at room temperatures.

Isn't your surest source of supply the one company with research, manufacturing and sales all devoted to Stainless Steel Valves exclusively?

ALLOY STEEL PRODUCTS COMPANY
Linden, New Jersey

Warning to all oilmen!

YOUR BIGGEST COMPETITOR— THE GASOLINE TAX— IS READY TO STRIKE AGAIN!

As every oilman knows, gasoline taxes are your biggest competitor for the American motorist's gasoline dollar.

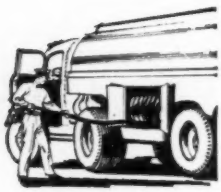
Now, according to reports from Washington, Congress will be asked to raise the federal gasoline tax again—by as much as *2¢ on every gallon!*

TODAY: The American motorist pays federal and state gasoline taxes* equal to:

41% of the retail price on every gallon

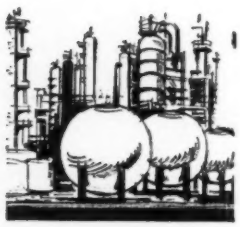
54% of the tank wagon price on every gallon

80% of the refinery price on every gallon



TOMORROW: If this tax increase is allowed to go into effect, the American motorist will pay federal and state gasoline taxes* equal to:

50% of the retail price on every gallon



66% of the tank wagon price on every gallon

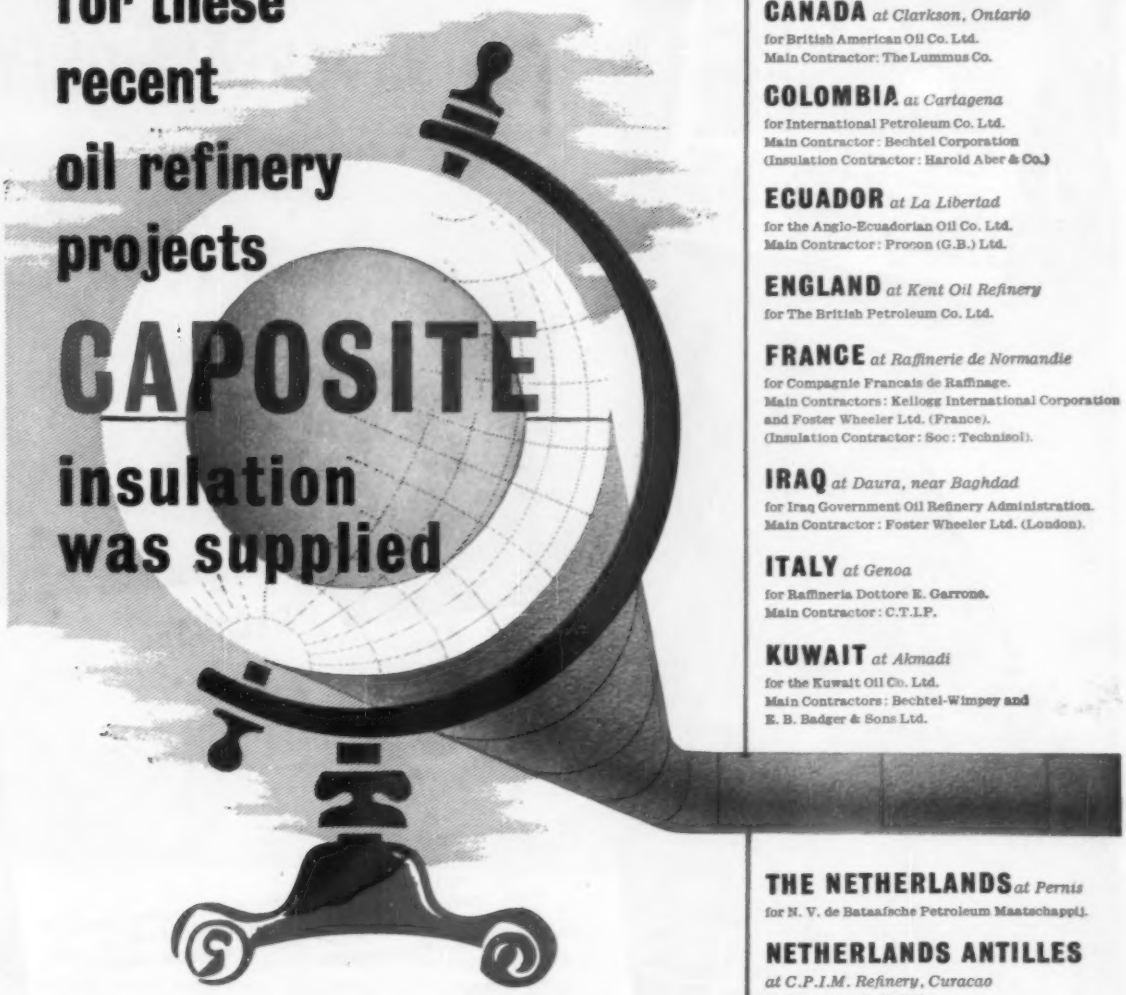
97% of the refinery price on every gallon

*Combined national average of state and federal gasoline taxes.

WHAT DO YOU THINK THE AMERICAN PEOPLE WILL SAY ABOUT THIS? CAN THEY AFFORD IT? WILL THEY BLAME YOU?

COMMITTEE ON PUBLIC AFFAIRS
of the
AMERICAN PETROLEUM INSTITUTE
50 WEST 50TH STREET • NEW YORK 20, NEW YORK

for these recent oil refinery projects CAPOSITE insulation was supplied



BAHRAIN *at Awali*
for Bahrain Petroleum Co. Ltd.
Main Contractor: Foster Wheeler Ltd.

BURMA *at Syriam*
for The Burma Oil Co. (1954) Ltd.
Main Contractor: Foster Wheeler Ltd. (London)

CANADA *at Clarkson, Ontario*
for British American Oil Co. Ltd.
Main Contractor: The Lummus Co.

COLOMBIA *at Cartagena*
for International Petroleum Co. Ltd.
Main Contractor: Bechtel Corporation
(Insulation Contractor: Harold Aber & Co.)

ECUADOR *at La Libertad*
for the Anglo-Ecuadorian Oil Co. Ltd.
Main Contractor: Procon (G.B.) Ltd.

ENGLAND *at Kent Oil Refinery*
for The British Petroleum Co. Ltd.

FRANCE *at Raffinerie de Normandie*
for Compagnie Francais de Raffinage.
Main Contractors: Kellogg International Corporation and Foster Wheeler Ltd. (France).
(Insulation Contractor: Soc: Technisol).

IRAQ *at Daura, near Baghdad*
for Iraq Government Oil Refinery Administration.
Main Contractor: Foster Wheeler Ltd. (London).

ITALY *at Genoa*
for Raffineria Dottore E. Garrone.
Main Contractor: C.T.I.P.

KUWAIT *at Akmadi*
for the Kuwait Oil Co. Ltd.
Main Contractors: Bechtel-Wimpey and E. B. Badger & Sons Ltd.

THE NETHERLANDS *at Pernis*
for N. V. de Bataafsche Petroleum Maatschappij.

NETHERLANDS ANTILLES
at C.P.I.M. Refinery, Curacao
for Royal Dutch-Shell Group.

SCOTLAND *at Grangemouth*
for British Hydrocarbon Chemical Co. Ltd.
Main Contractor: E. B. Badger & Sons Ltd.

VENEZUELA *at Maracaibo*
for The Richmond Exploration Co.
Main Contractor: The Lummus Co.

CAPOSITE regd.
Amosite Asbestos Blocks and Pipe Sections

Speedy application .... long-lasting protection .... resilience to withstand rough handling .... long fibred Amosite asbestos, giving superior insulating properties — these are the reasons why CAPOSITE is being specified for more and more of today's refineries.

CAPOSITE *is also manufactured in*
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Tel: GROsvenor 6022 Cables: Incorrupt London

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Cape Asbestos (Canada) Ltd., 200 Bloor Street East, Toronto, Ont.
U.S.A. to: North American Asbestos Corpn., Board of Trade Building, Chicago, 4, Illinois

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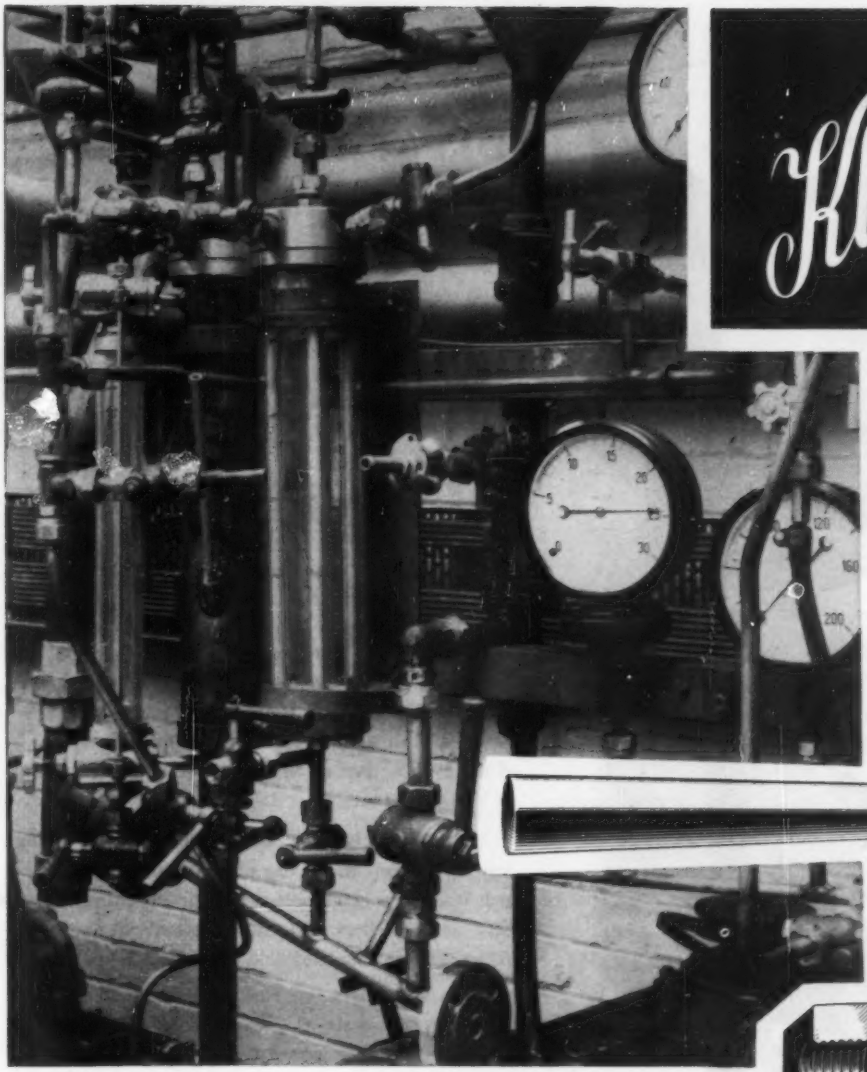
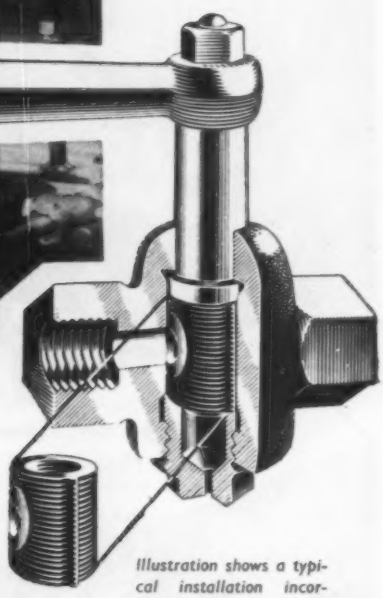
ALL USERS OF
OPEN STEEL FLOORING
CAN SAVE REAL MONEY
by specifying
FLOWFORGE
FORGE-WELDED
OPEN STEEL FLOORING
Plain or Serrated edges
(plain edges illustrated)
FLOWFORGE is approved by:
The British Admiralty; Esso Petroleum Company Ltd.; I.C.I. (Billingham Division); I.C.I. (Alkali Division); I.C.I. (General Chemical Division); Kellogg International Corporation; Shell Tankers Ltd.; Shell Refining Company; George Wimpey & Company Ltd.; Mobil Oil Company Limited.
BECAUSE:
SPECIFICATION
Flowforge is a monolithic open flooring product of EXCLUSIVE FORGE-WELDED CONSTRUCTION. It is designed to meet British and Foreign specifications. Twisted crossbars give a non-slip surface.
SERVICE
Large stocks of standard 20ft. x 3ft. panels are held ready for IMMEDIATE delivery. Delivery schedules for tailor-made panels can be arranged to meet site requirements.
SAVING
The exclusive manufacturing method ensures substantial savings in first cost—it is cheaper to buy Flowforge. Flowforge gives greatest covering area per ton; is easy to handle and fix; is completely adaptable to the job; has no crevices to hold moisture and start corrosion; is easy to clean, paint and maintain.
Our Advisory Service is available to solve your problems relating to open steel flooring—for original floors, mezzanine floors; stairways, fire escapes, gangways, bridges, catwalks, ships walk-ways, scaffolding platforms, earthing frames, etc.
Fisher & Ludlow Ltd

MATERIAL HANDLING DIVISION · BORDESLEY WORKS
BIRMINGHAM 12 ENGLAND
Cables: FLOWLINE, BIRMINGHAM, ENGLAND



Klinger

SLEEVE-PACKED COCKS



In the last quarter of a century Klinger Sleeve-Packed Cocks have steadily replaced the old-fashioned asbestos-packed cocks with their limitations of working pressure, difficulty of repacking and tendency to jam. They are available in a wide range of designs and sizes for all purposes and pressures, and with the following advantages:

- **Renewable "Klingerit" packing sleeve.**
- **Re-tightening during use.**
- **Parallel-ground non-jam plug.**
- **Unobstructed straight-thru full-bore passage.**

Illustration shows a typical installation incorporating Klinger Sleeve-Packed Cocks, at a famous research establishment.

THE KLINGER CORPORATION OF AMERICA, 95 RIVER STREET, HOBOKEN, NEW JERSEY.
Telephone: Oldfield 6-1300

Manufacturing Licensees for Canada

JOSEPH ROBB & COMPANY LIMITED, 5575, COTE ST. PAUL ROAD, MONTREAL, 20, CANADA
Telephone : GLENVIEW 9151
Branches at: SYDNEY, HALIFAX, OTTAWA, TORONTO, HAMILTON, WINNIPEG, EDMONTON, VANCOUVER, QUEBEC CITY

RICHARD KLINGER LIMITED, KLINGERIT WORKS, SIDCUP, KENT, ENGLAND.

GA42/58/C

NEWALLS *present an*

ABC

GUIDE TO REFINERY INSULATION

Aden, Bombay, Cuba—we could equally well start with Amuay, Antwerp, Bahrain, Cardon, Cubatao—or go back to Abadan—or even to Astra-Romana of the 1920's, then on through some 40 oil refineries to Visakhapatnam.

Wherever oil is to be refined you are likely to find Newalls insulation. As one of the world's largest heat insulation manufacturers and contractors, Newalls have contributed extensively to thermal efficiency in this highly specialised field for over 25 years.

Newalls supply a range of insulating materials to operate at temperatures from —300°F. up to over 2,000°F. that have proved themselves in oil refineries and petrol-chemical plants in most countries.

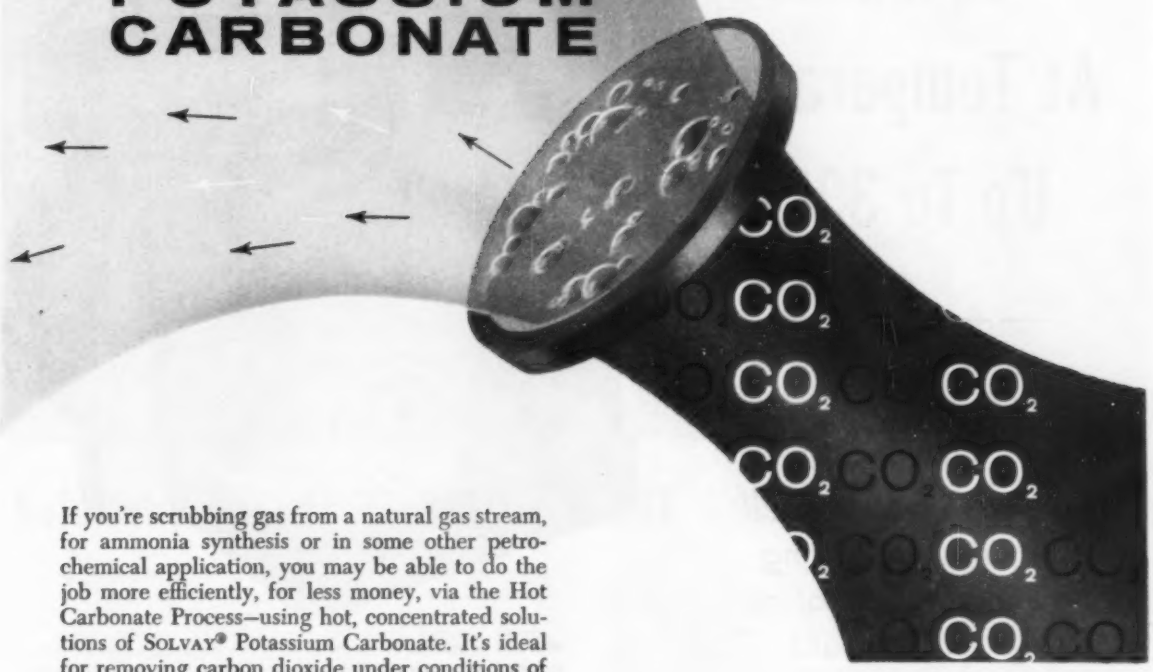
Newalls also provide a Technical Advisory Service with long experience of all types of insulation questions from design to completion.

Newalls

NEWALLS INSULATION CO. LTD.
Head Office:
Washington, County Durham, England
A member of the TURNER & NEWALL ORGANISATION
AGENTS AND VENDORS IN MOST MARKETS ABROAD

Scrub Carbon Dioxide from Process Gases

with SOLVAY POTASSIUM CARBONATE



If you're scrubbing gas from a natural gas stream, for ammonia synthesis or in some other petrochemical application, you may be able to do the job more efficiently, for less money, via the Hot Carbonate Process—using hot, concentrated solutions of SOLVAY® Potassium Carbonate. It's ideal for removing carbon dioxide under conditions of fairly high concentration and partial pressure from process gases.

You save over other methods because the circulating carbonate solution is used hot. This eliminates costly heat exchangers and reduces the process steam requirement.

To help you compare the hot potassium carbonate method with other gas-scrubbing processes, mail the coupon for any of the six authoritative articles from major chemical and petroleum publications or the booklet, "SOLVAY Potassium Carbonate."

Sodium Nitrite • Calcium Chloride • Chlorine • Caustic Soda • Chloroform
Caustic Potash • Potassium Carbonate • Sodium Bicarbonate • Soda Ash
Monochlorobenzene • Para-dichlorobenzene • Ortho-dichlorobenzene
Ammonium Chloride • Methylene Chloride • Carbon Tetrachloride • Vinyl
Chloride • Methyl Chloride • Ammonium Bicarbonate • Hydrogen Peroxide
Snowflake® Crystals • Aluminum Chloride • Mutual® Chromium Chemicals
Cleaning Compounds

Allied Chemical

SOLVAY PROCESS DIVISION
61 Broadway, New York 6, N. Y.

SOLVAY branch offices and dealers are located in major centers from coast to coast.

SOLVAY PROCESS DIVISION
ALLIED CHEMICAL CORPORATION
61 Broadway, New York 6, N. Y.

Please send me without obligation the articles checked:

- ☐ "For bulk removal of acid gases . . . Costs Favor Hot Carbonate Process"—Chemical Engineering.
- ☐ "CO_2 Removal from Natural Gas"—Oil and Gas Journal.
- ☐ "Economics of Acid-Gas Removal"—Oil and Gas Journal.
- ☐ "Improved Process for CO_2 Absorption"—Chemical Engineering Progress.
- ☐ "Which CO_2 Removal Scheme Is Best?"—Petroleum Refiner.
- ☐ "Florida's First Synthetic NH_3 Plant"—Chemical Processing.
- ☐ "SOLVAY Potassium Carbonate" fact book.

Name_____
Position_____
Company_____
Phone_____
Address_____
City_____ Zone_____ State_____

For more data on advertised products, use Readers' Service Cards, last page.

New Protection For YOUR Equipment— At Temperatures Up To 3300°F

ALUNDUM castables offer unusual advantages to all industries using high temperature installations*

Will fire continuously up to 3300°F. This Harrop gas-fired furnace, recently developed by the Electric Furnace Division of the Harrop Ceramic Service Company, Columbus, Ohio, is particularly applicable to the firing of ceramic oxide bodies. Norton ALUNDUM 33-I Insulating Castable selected for the inner lining of the furnace and its roof, provided completely satisfactory protection under repeated tests at highest operating temperatures.

The new Norton ALUNDUM Castables are made in two types: 33-I Insulating and 33-HD Heavy Duty. At temperatures up to 3300°F both types have been extremely successful in protecting high temperature processing — in many industries and many different installations.

ALUNDUM 33-I Insulating Castable is made up primarily of pure aluminum oxide bubbles, tiny and countless. Forming a network of air spaces, it assures excellent insulation, even at highest commercial temperatures.

ALUNDUM 33-HD Heavy Duty Castable is chiefly composed of dense grains of pure aluminum oxide. It is recommended for forming dense monolithic surfaces in many types of furnaces where high temperature conditions are particularly severe.

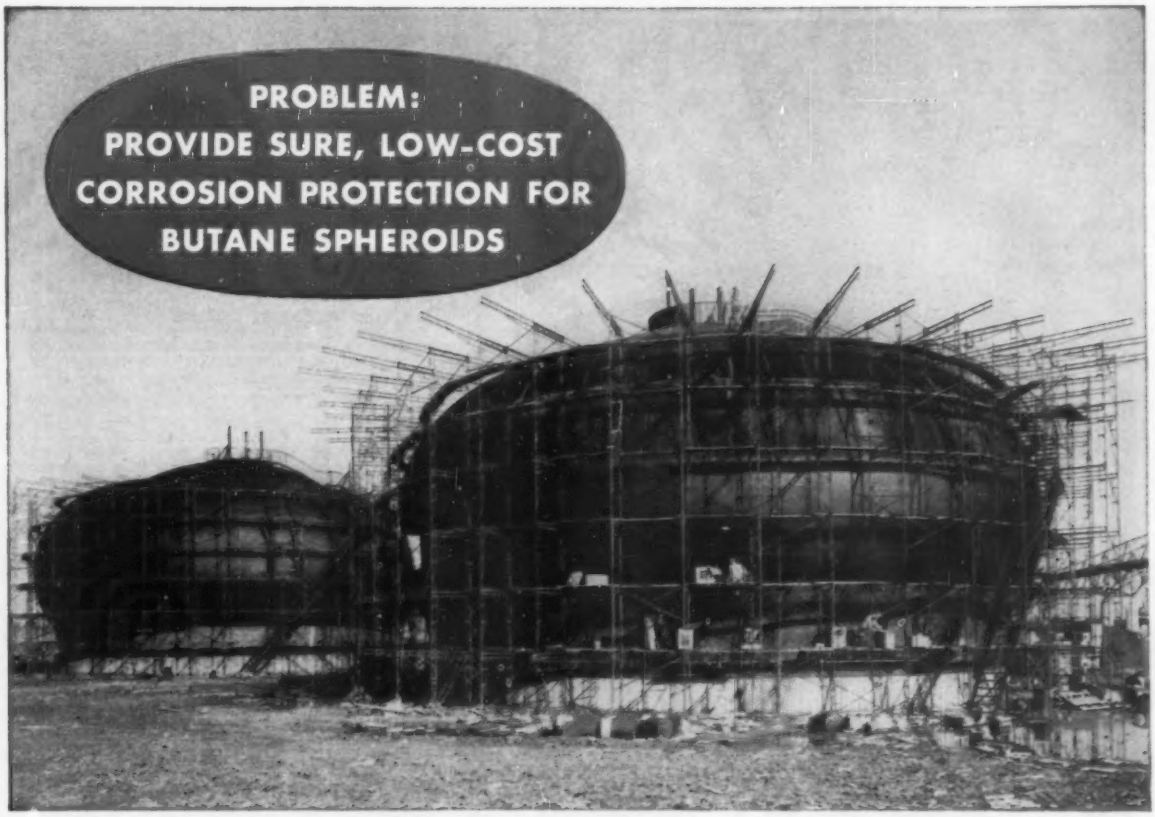
Both 33-I and 33-HD Castables are very easy to store, mix and use. With them you can cast simple or complex shapes quickly and economically, replace more expensive pre-fired shapes, and cut maintenance and replacement costs to very lowest. Ask your Norton Representative for details, and for the folder *Two Norton Castables.* Or write to NORTON COMPANY, Refractories Division, 473 New Bond Street, Worcester 6, Massachusetts.

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

NORTON
REFRACTORIES
Engineered... Rx ...Prescribed

Making better products . . . to make your products better

NORTON PRODUCTS Abrasives • Grinding Wheels • Grinding Machines • Refractories • Electrochemicals — **BEHR-MANNING DIVISION** Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes



Solution: Specify Time-Tested PITT CHEM *Insul-Mastic*

SELECTION of a durable, heavy-duty moisture and vapor seal was an important consideration in planning the corrosion and insulation protection of five 40,000-barrel spheroid butane tanks at a large East Coast refinery.*

Because of its long record of maintenance-free service in the petroleum industry, Pitt Chem *Insul-Mastic* Gilsonite coating was specified for the job. Foam glass type insulation blocks were imbedded in *Insul-Mastic* #4010 Vaporseal. The same material was used for all joints and sprayed as a final weather sealing coat to protect the efficiency of the insulation and prevent corrosion of the metal structures. A glass membrane was imbedded in the weather sealing coat to assist in withstanding structural movement. Geo. V. Hamilton, Inc., Pittsburgh, was contractor for the job.

Pitt Chem *Insul-Mastic* coatings have no equal in stopping moisture vapor penetration. Unlike ordinary asphaltic coatings, they contain *Gilsonite*, one of the most chemically resistant bitumens known. They withstand extremes of heat and cold, moisture and dryness, expansion and contraction.

Specify Pitt Chem *Insul-Mastic* for *your* next corrosion-proofing or vapor sealing job. You'll be using the same protection applied to many hundreds of pieces of equipment in the petroleum industry, many of which have been *Insul-Mastic*-protected for nearly two decades with little or no maintenance cost.

Pitt Chem *Insul-Mastic* Coatings are available through your local industrial distributor. Call him today for more information, or write direct for a Pitt Chem Corrosion Protection Guide.

*Name on request.

Think First of the Coatings that Last!

PITT CHEM
Coal Tar Coatings

PITT CHEM
"Insul-Mastic" Gilsonite Coatings

PITT CHEM
"Tarset" Coal Tar Epoxy Coating

PITT CHEM Industrial Coatings are available through leading Industrial Distributors. See the "Yellow Pages."

COAL CHEMICALS • PROTECTIVE COATINGS • PLASTICIZERS • ACTIVATED CARBON • COKE • CEMENT • PIG IRON

For more data on advertised products, use Readers' Service Cards, last page.

RING OF STEEL

Defies Pressure Times Ten

The Flexitallic gasket in the bonnet joint of Hancock Steel Gate Valves cannot blow out even if pressures exceed ten times the rating of the valve. Valve maintenance and equipment down-time are greatly reduced. Made of a spiral-wound ribbon of stainless steel with asbestos filler, the gasket has spring-like compressibility — cannot be flattened.

Only the specially-designed Hancock bonnet joint with built-in compression limit can make full use of the positive sealing power of this ring of steel. Such advanced valve engineering is one example of total Hancock quality that assures trouble-free performance. Your nearby industrial supply distributor will gladly explain every economy feature of Hancock Steel Gate Valves. Phone him today.

Hancock 800# Steel Gate Valve, Type 950. Sizes: ¼" thru 2".

MANNING MAXWELL & MOORE INC. TRADE MARK

H3-58

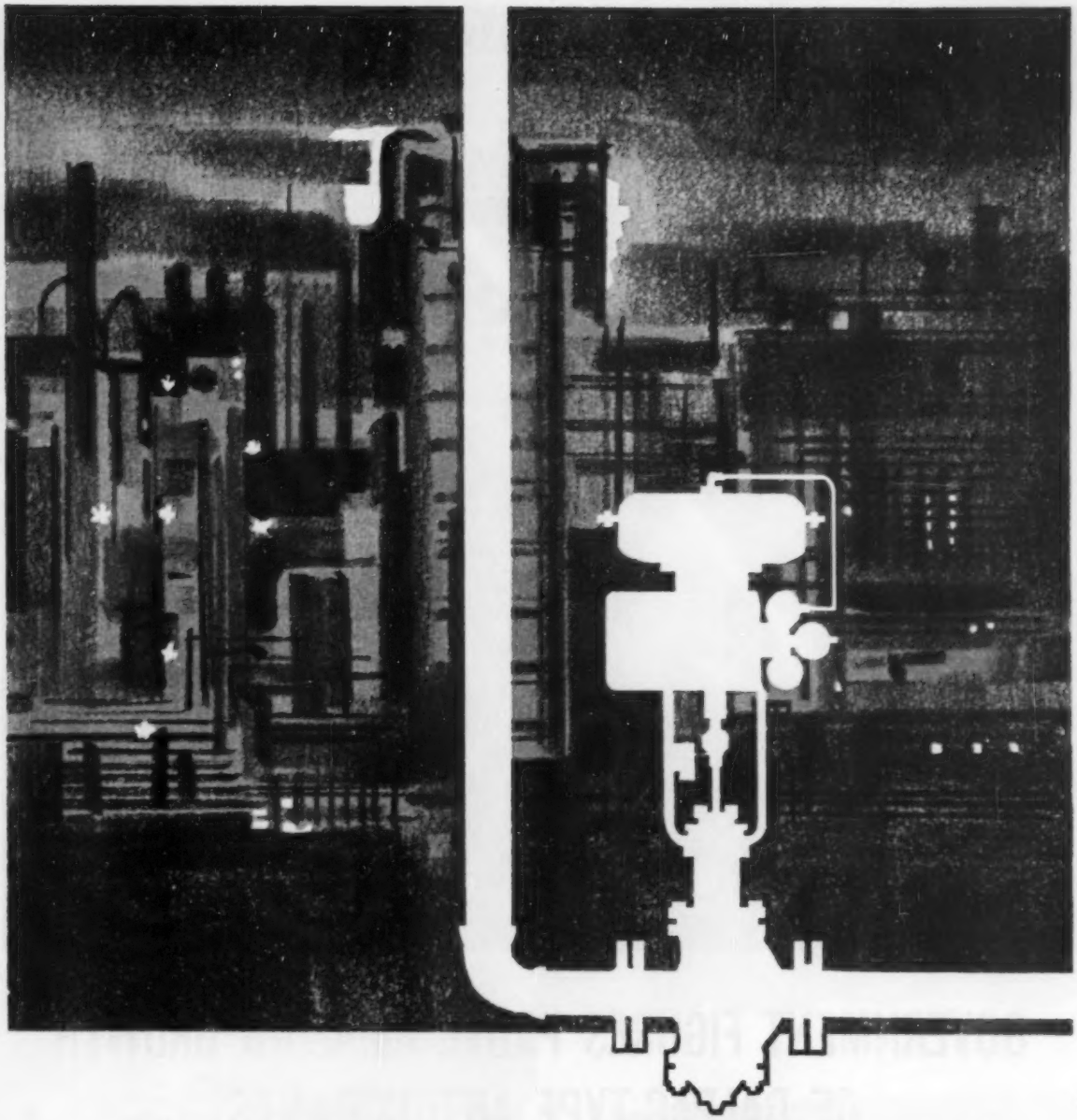
HANCOCK STEEL VALVES

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Watertown, Massachusetts
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

For more data on advertised products, use Readers' Service Cards, last page.



...almost forgotten...because it does its job so well!

Dependable, year-after-year performance makes a Fisher Diaphragm Motor Valve the preferred control in the power and process industries. The Fisher D.M.V. has features not available on other brands. The extra thick steel casing, the precision finished valve stem, the large capacity and the trouble-free operation —these are just a few of the reasons a Fisher gets the nod when it comes to diaphragm motor valve selection.

If you want to know more about the ultimate in control—the Fisher Diaphragm Motor Valve —write for Bulletin E657A.

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD... CHANCES ARE IT'S CONTROLLED BY...

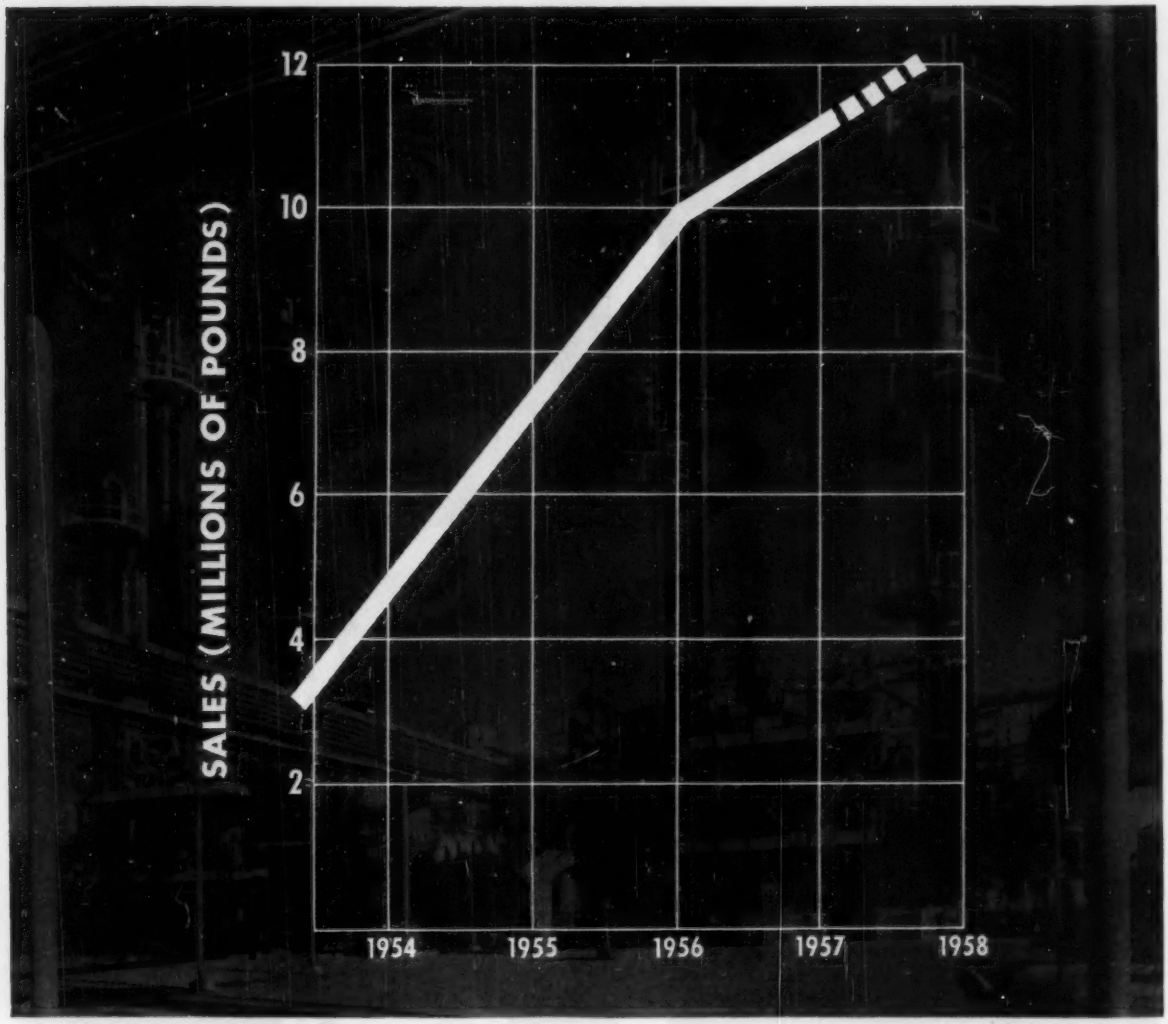
FISHER GOVERNOR COMPANY

Marshalltown, Iowa / Woodstock, Ontario / London, England

FISHER® Controls

SINCE 1880

For more data on advertised products, use Readers' Service Cards, last page.



GOVERNMENT FIGURES PROVE AMAZING GROWTH OF DALPAC-TYPE ANTIOXIDANTS

Figures of the U. S. Tariff Commission show the astounding growth of di-tert-butyl-p-cresol in just three years—almost tripled!

Dalpac 4, Hercules di-tert-butyl-p-cresol, has firmly established itself as a leading antioxidant in many industries where hydrocarbon stability is a problem. Petroleum refiners, for example, rely on Dalpac to inhibit gum formation, stabilize gasoline color and prevent engine deposits. They use it in turbine and transformer oils to prevent deterioration. Dalpac 4 has no effect upon electrical properties, which makes it ideal for use in transformer oils.

These are but a few indications of where this Hercules antioxidant can serve you. Since Hercules is a basic integrated producer starting with the raw material, you can count on a dependable source of supply. We will be glad to answer your inquiries and send technical information.

DALPAC® 4

Oxychemicals Division • Naval Stores Department
HERCULES POWDER COMPANY
INCORPORATED
900 Market Street, Wilmington 99, Delaware

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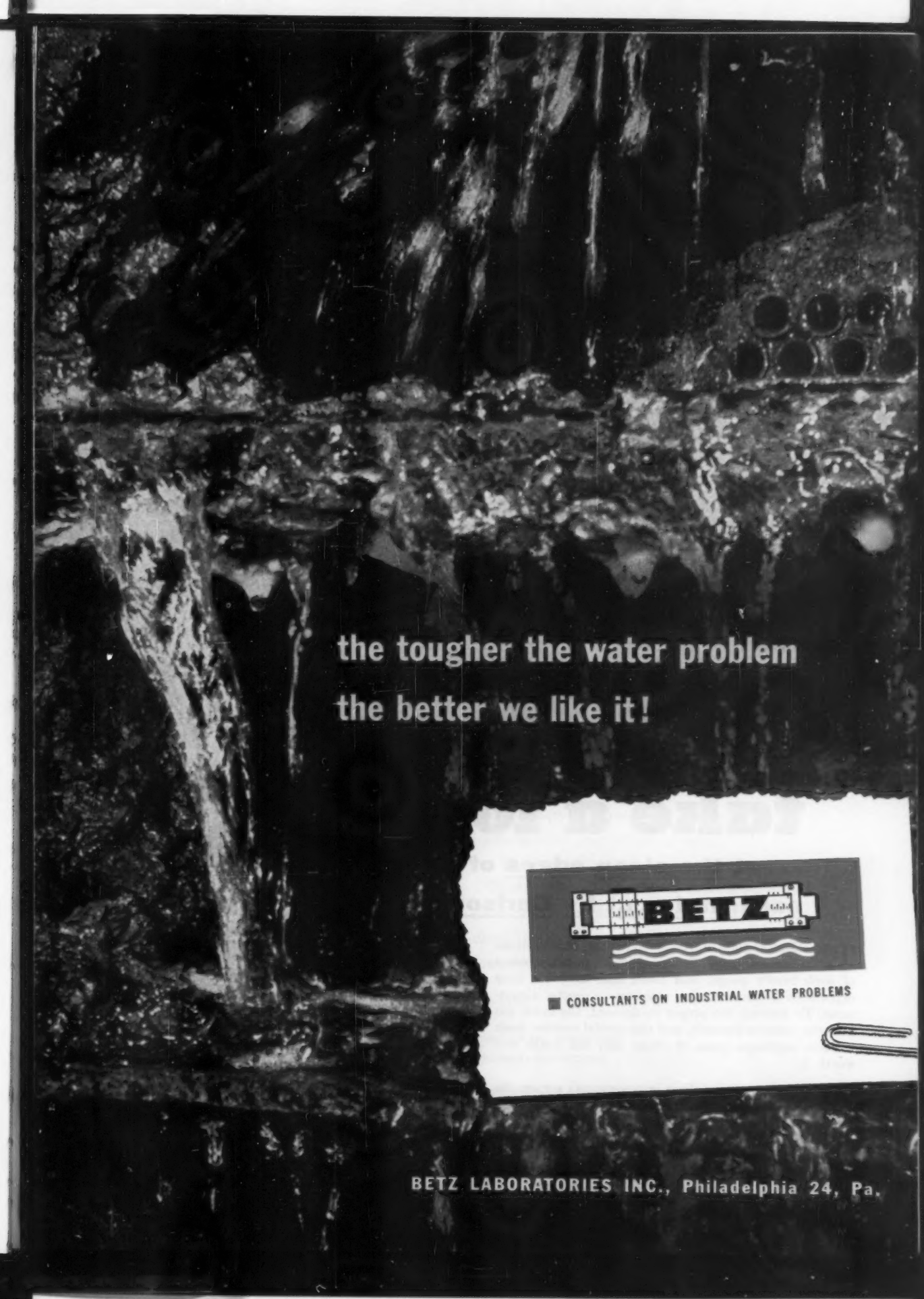

the tougher the water problem
the better we like it!
BETZ
CONSULTANTS ON INDUSTRIAL WATER PROBLEMS
BETZ LABORATORIES INC., Philadelphia 24, Pa.

Type 304 stainless plate, dimensions: 6⅛" thick x 75" diameter. Weight, 8655 lbs.

take a look

...at the clean edges of this stainless plate accurately cut by Carlson

THIS stainless plate illustrates something that's almost a Carlson exclusive. Few producers can make plates of such heavy gauge, and fewer still have the long experience in flame cutting stainless to precise dimensions. To develop the proper equipment, the exact gas and iron powder formula, and the special nozzles, took Carlson engineers years of effort. But the result was worth it.

The edges achieved by these improvements reduce the cost of subsequent machining operations. And every Carlson stainless plate—whether heavy or light gauge—carries its own identification. Its chemical and physical properties are known and recorded. Its dependable performance on the job is assured.

The complete reliability of every Carlson service will materially reduce your ultimate costs. Our specialists make certain that your instructions are followed in every detail. Write, wire or phone for further information on all our services in stainless steel.

G.O.CARLSON Inc.

Stainless Steels Exclusively

136 Marshalton Road
THORNDALE, PENNSYLVANIA
District Sales Offices in Principal Cities

PLATES • PLATE PRODUCTS • HEADS • RINGS • CIRCLES • FLANGES • FORGINGS • BARS AND SHEETS (No. 1 Finish)

pumps, pours, dissolves under any condition

UOP AW(50)*

COPPER DEACTIVATOR

Even in exposed, below-freezing locations, UOP AW(50) Copper Deactivator flows readily, doing away with low-temperature pumping problems common to ordinary deactivators. And, whether you use AW(50) in the five-gallon manual-application size, or 55-gallon drums for automatic injection, it will not freeze and can be easily pumped even when stored for long periods at temperatures as low as 0°F.

In addition to superior pouring properties under low-temperature conditions AW(50) gives maximum metal deactivating efficiency and economy. It is instantly soluble in hydrocarbons, and is light in color.

UOP AW(50) is a "must" for refiners stabilizing gasoline, jet fuel, domestic heater oil and diesel fuel in all northern latitudes where temperature drops are extreme.

*Trade Mark

Made and sold exclusively by
PRODUCTS DEPARTMENT

UNIVERSAL OIL PRODUCTS COMPANY

30 ALGONQUIN ROAD
DES PLAINES, ILLINOIS, U.S.A.

For more data on advertised products, use Readers' Service Cards, last page.

ARE YOU GETTING YOUR SHARE OF THE HIGH OCTANE MARKET?

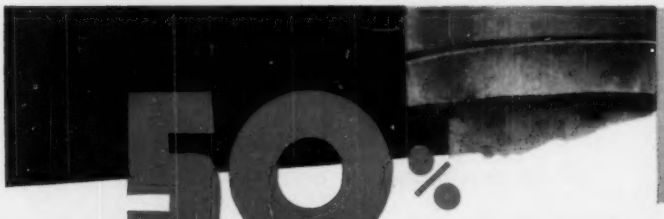
The consumption of Alkylate is growing for both government and civilian use, and this demand is expected to continue, at least into the middle 1960s. To get your share of the high octane market, consider adding an Alkylation Unit to your facilities as soon as possible.

The Oil and Gas Journal says, "Of the five typical high-quality blends which go into premium gasoline, alkylate is by far the best performer . . . more and more refiners are being pushed to include alkylate in their motor fuels. Heavy competition . . . is responsible for the new emphasis on alkylation."

	Research octane (RON)	Motor octane (MON)	Sensitivity (RON minus MON)	Road octane (Union town)
Alkylate	103.0	104.5	−1.5	107.5
Reformate extract	103.7	94.0	9.7	103.5
C_7 plus reformate	103.0	93.5	9.5	102.5
C_6 plus reformate	100.0	91.7	8.3	100.0
Catalytic cracked	99.0	87.5	11.5	98.0

Reprinted courtesy The Oil and Gas Journal (Aug. 4, 1958)

WHY ALKYLATE IS THE KEY TO CURRENT GASOLINE BLENDS . . .



OVER 50% OF ALL POST-WAR HF ALKYLATION UNITS OPERATING IN NORTH AMERICA WERE DESIGNED, ENGINEERED AND BUILT BY TRECO*

The Refinery Engineering Company has designed, engineered and constructed more HF alkylation units than all other companies combined.

THE TRECO LIST INCLUDES:

Shell Oil Company of Canada	1500 BPSD
NCRA	1522 BPSD
Cosden Petroleum Company	2068 BPSD
DX-Sunray (Tulsa)	2470 BPSD
DX-Sunray (Duncan)	3500 BPSD
CRA	1106 BPSD
Anderson-Prichard Oil Corp.	2150 BPSD
Bell Oil & Gas Company	1000 BPSD
The Carter Oil Company	2300 BPSD

Treco, with an outstanding record of fast refinery completion, can have your alkylation unit on stream QUICK. A telegram, telephone call or letter will bring complete information.

*to September 30, 1958

....talk with the TRECO man.....

TRECO

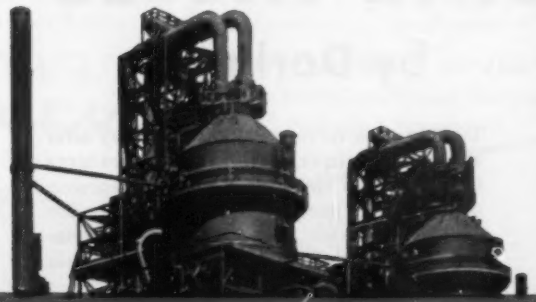
A DIVISION of VITRO CORPORATION of AMERICA

The REFINERY ENGINEERING Company

FARMINGTON NEW YORK TULSA TORONTO

There is a specific A. P. Green Castable for every refractory application in the Petroleum Field. Methods of installation, including troweling, pouring, and "gun" application vary with the particular characteristics of the job. Each A. P. Green castable refractory is specifically designed to provide the required properties of insulation, strength, abrasion resistance and refractoriness for high efficiency operation.

For detailed information and recommendations write the Engineering Department of the A. P. Green Fire Brick Company . . . or call your local A. P. Green distributor.



KAST-SET

A. P. Green KAST-SET is a rapid setting, high strength refractory castable. Mixed with water, it takes on a hydraulic bond without the application of heat. KAST-SET will not shrink, has excellent resistance to abrasion, and is ideally suited for monolithic linings. It may be used at temperatures up to 2700°F.

KAST-O-LITE

A lightweight, insulating castable refractory recommended for temperatures up to 2500°F. It is used for complete monolithic linings in all types of oil stills and heaters, tar stills, air heaters, heat treating furnaces, flues and stacks, and for furnace hearth insulation.

CASTABLE INSULATION NO. 20

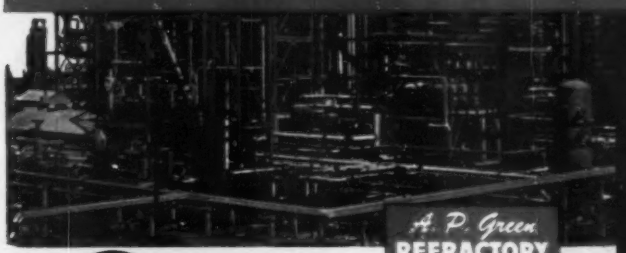
A hydraulic-setting castable for temperatures up to 2000°F. Recommended for complete monolithic linings and lightweight panel construction in oil stills and heaters.

CASTABLE BLOCK MIX

A hydraulic-setting castable insulation for temperatures up to 1600°F. CASTABLE BLOCK MIX combines the advantages of a castable material with low conductivity and light weight.

A.P. GREEN

HIGH QUALITY REFRACTORY AND INSULATING CASTABLES ASSURE HIGH EFFICIENCY OPERATION OF PETROLEUM EQUIPMENT



ESSO Esso Standard Oil Company's fluid catalytic cracking units at the Baton Rouge Refinery where A. P. Green products are in use.

A. P. Green REFRACTORY PRODUCTS

A. P. GREEN FIRE BRICK COMPANY
Mexico, Missouri, U. S. A.

PLANTS:
Mexico, Mo.—Woodbridge, N. J.—Sulphur Springs, Texas, Jackson, Oak Hill, South Webster, Ohio • Philadelphia, Pa. Troy, Idaho • Pueblo, Colo. • Macon, Ga.

IN CANADA:
A. P. Green Fire Brick Company, Ltd.—Toronto 15, Ontario

DISTRIBUTORS IN THE PRINCIPAL CITIES OF THE WORLD

CASTABLES FOR GUN APPLICATION

SK-7 and KS-4
were designed for use in combination to form composite linings in catalytic regenerators, reactors, and other petroleum equipment. Frequently a lining utilizing only SK-7 or KS-4 will fulfill the requirements of the job.

SK-7
Gun application of SK-7 produces a lightweight lining with excellent strength and insulating efficiency. Ideal lining for ducts, flues and breechings.

KS-4
This strong abrasion resistant castable can be gun applied with a minimum of rebound loss. Recommended for catalytic regenerator linings, stack linings, bubble towers, and duct linings exposed to abrasion or corrosion.

For more data on advertised products, use Readers' Service Cards, last page.

ALUMINUM GATE VALVES

by Darling

Darling gate valves of aluminum alloy offer all of the unique, extended-life features inherent with the Darling fully revolving double disc, parallel seat principle... for performance that assures unmatched economy... and freedom from leakage, trouble and downtime!

These Darling aluminum alloy valves are now available in ½" through 24" sizes. Write for full details, specifying your particular service requirements.

DARLING
DARLING
VALVES

DARLING VALVE & MANUFACTURING CO.
WILLIAMSPORT 31, PA.

Standard or special, simple or complex—

M-S-A Sample Systems and Accessories help produce unerring answers to your gas analysis problems

Proper handling of a sample stream can make a critical difference to the analytical instrument user. It may well be *the* determining factor in achieving positive results.

That's why the subject of proper sample handling has received so much emphasis at MSA. Already, we have spent thousands of engineering manhours on design, development, and testing of sampling systems and sample system components. Specifically, for use with M-S-A Infra Red, Thermatron, Oxygen, Combustible Gas, Water Vapor, and Carbon Monoxide Analyzers.

A great majority of the analyzers that we build have been supplied as part of a complete system, including all necessary sampling accessories. Because of the variety of sample conditions, a single system will not satisfy all requirements. Many MSA systems have been successfully applied so many times, however, that they have become standard. In other cases, we have developed special combinations of these standard units to handle problems peculiar to a certain application. Or, we have supplied individual components to a user where the application has not required an elaborate system.

An MSA Instrument Specialist can help you pinpoint the results you can expect from MSA Analyzers equipped with any or all of these versatile units. Our new bulletin, *M-S-A Sample Systems and Accessories for Gas Analysis* lists applications, features and advantages for the complete line. Write for your copy.

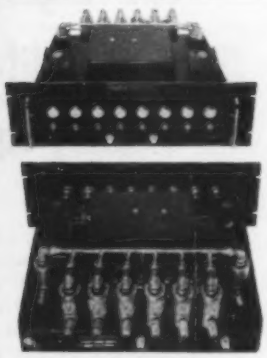
M-S-A Standard Systems

INSTRUMENT DIVISION
Mine Safety Appliances Company
Pittsburgh 8, Pennsylvania

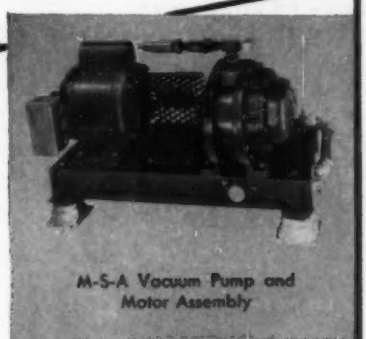
M-S-A Heavy Duty Primary Filter or Scrubber

M-S-A Water Cooled and Air Cooled Sample Conditioners

M-S-A Combination Filter and Liquid Separator



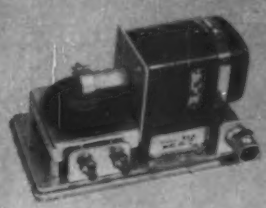
M-S-A Station Selector *Multipoint*



M-S-A Vacuum Pump and Motor Assembly

M-S-A High Efficiency Small Volume Filter

M-S-A Low Pressure Regulator



M-S-A Diaphragm Pump and Motor Assembly

higher octane levels and longer catalyst life...with existing equipment

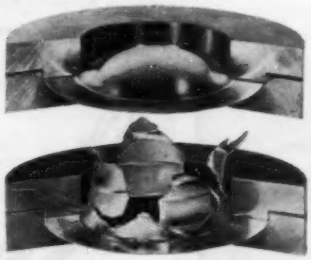
If you have the problem of increasing octane rating and production, investigate Sinclair-Baker RD 150! You can do it with your existing equipment, merely by replacing with Sinclair-Baker RD 150 Platinum Catalyst. Its efficiency in producing important yield increases at high octane levels is a matter of record. The long period of RD 150 operation is unmatched by any other catalyst . . . further, it is regenerative in situ! Costs are sharply reduced to lowest level. A representative will be glad to give you detailed information upon request. All data of confidential nature are of course treated accordingly. Literature is available.

CHEMICAL DIVISION • 113 ASTOR STREET
NEWARK, N.J.

for detection, measurement of oxygen or hydrogen impurities in other gases

This SUPER SENSITIVE DE-OXO INDICATOR continuously measures oxygen or hydrogen present as impurities in other gases. Accurately indicates from 0.0002% to 0.0200% (2 to 200 parts per million) oxygen and from 0.0004% to 0.0400% hydrogen. A dual range permits measurement of up to 0.25% oxygen or 0.5% hydrogen.

CHEMICAL DIVISION • 113 ASTOR STREET
NEWARK, N.J.



instant automatic release of excess pressure

Platinum, gold, and silver are now generally recognized as specifics when dealing with corrosion. Each is resistant to the corrosive effects of an important group of liquids and gases and will remain unattacked under conditions that would render many base metal materials useless. These rupture discs, depending on material selected, are guaranteed to be burst ± 5% of specified pressure.

BAKER PLATINUM DIVISION • 113 ASTOR STREET
NEWARK, N.J.

CHEMICAL DIVISION

ENGELHARD INDUSTRIES, INC.

EXECUTIVE OFFICES:
113 ASTOR STREET • NEWARK 2, NEW JERSEY

BAKER PLATINUM DIVISION

corrosion coupons prove...

KONTOL

REDUCED CORROSION IN PLATFORMER OVERHEAD VAPOR RECOVERY SYSTEM FROM 11.74 TO .14 MPY*

In an eastern refinery severe corrosion was encountered in the prefractionator overhead vapor recovery system in one of its platformers. This unit was charged with about 1500 b/d of naphtha—300 bbls. overhead, 1200 bbls. removed as side cut and used as charge to reactors.

After the first month of operation, overhead vapor line and reflux line of silica tower and clay tower had to be replaced. Reflux pump and reactor charge pump had to be relined and new impellers installed. Severe corrosion was noted in condenser bundles. Throttling valves were renewed several times.

KONTOL was then injected into the overhead vapor line from the prefractionator. Corrosion test coupons installed in a by-pass on the reflux line revealed the following results:

Date Installed	Date Removed	M. P. Y.*	Kontol
12/18	12/26	11.74	No
12/26	1/2	7.96	Yes
1/19	2/2	.41	Yes
2/2	2/23	.17	Yes
2/23	4/28	.12	Yes
5/13	10/12	.14	Yes

*Mils penetration per year

Here's another coupon...
to help you control your corrosion problems

(check and mail to the address nearest you)

TRETOLITE COMPANY
Divisions of Petrolite Corporation
☐ 369 Marshall Avenue, St. Louis 19, Missouri
☐ 5515 Telegraph Road, Los Angeles 22, California
Gentlemen: Please send me copy of latest KONTOL Brochure, complete with performance data, case histories, etc. No obligation to me.
Name_____
Address_____
City_____ State_____

TRETOLITE COMPANY

DIVISIONS OF PETROLITE CORPORATION

369 Marshall Avenue, Saint Louis 19, Missouri
5515 Telegraph Road, Los Angeles 22, California

Chemicals and Services for the Petroleum Industry

DESALTING • CORROSION INHIBITING
DEMULSIFICATION • SCALE PREVENTION • WATER
DE-OILING • METAL DEACTIVATION • ADDITIVES

KR-58-2

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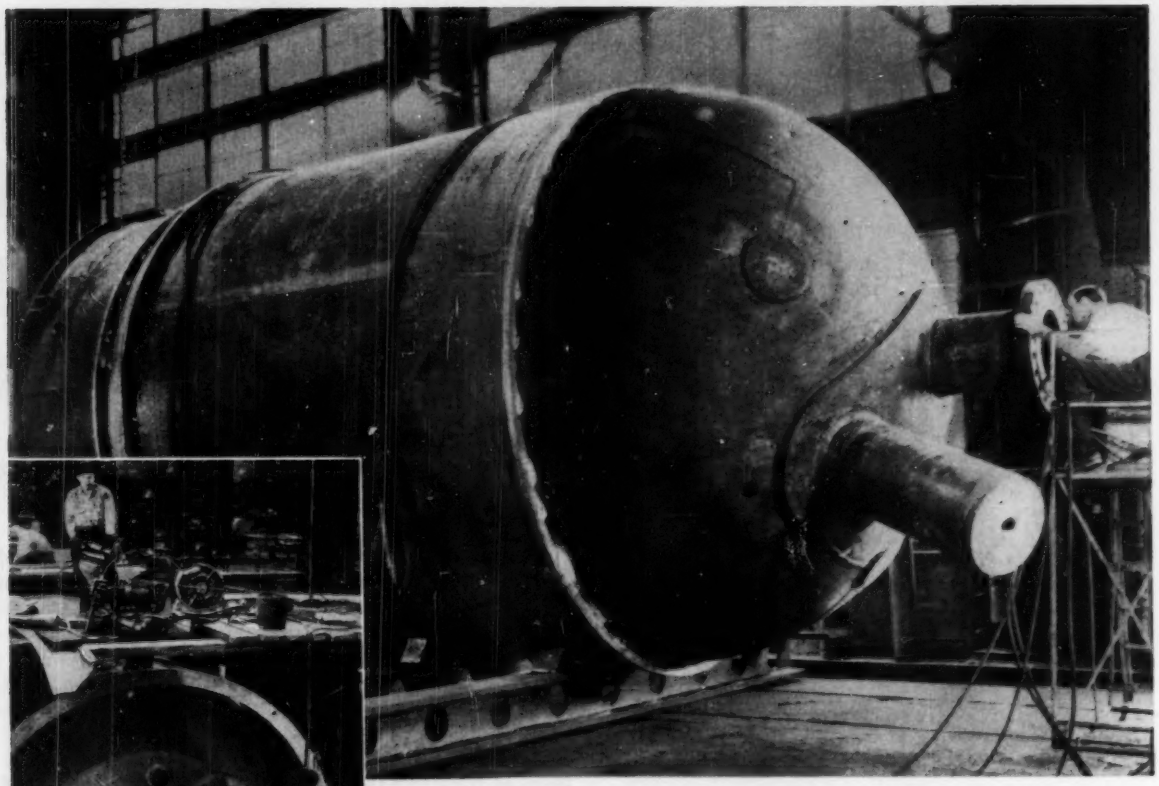
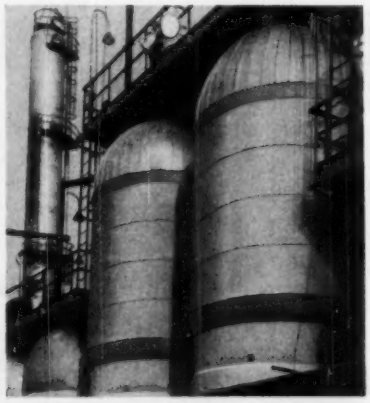
20 ft. long, 12 ft. in diameter, 13 kinds of steel . . . typical of the tough pressure vessel welding jobs Baldwin is noted for



Built by B-L-H's Eddystone Division, a 100-ton pressure vessel made chiefly of chrome molybdenum steel is here shown being inspected by an Eddystone engineer.

Automatic submerged metal arc was one of three welding methods employed on this huge pressure vessel.



Identical vessels fabricated by B-L-H and installed in the catalytic reforming unit of an ultramodern refinery.

A major oil company recently called on Baldwin-Lima-Hamilton's Eddystone Division to weld two identical 100-ton pressure vessels that must operate continuously for long periods of time at nearly 1000°F in a hydrogen-rich atmosphere at pressures up to 536 psi. Baldwin successfully met the challenge of this big job.

Thirteen different kinds of steel ⅜ in. to 5⅛ in. thick and three welding methods—manual-shielded metal arc, automatic submerged metal arc, and inert gas — had to be used on the vessels, each 20 ft. long, 12 ft. in diameter. As on all Baldwin work, only qualified welders were used.

Radiographic inspection of all welds revealed no defects. After the vessels were hydrostatically tested at 1575 psi for 3 hours, all seams were examined for leaks and found to be tight.

For a copy of our illustrated Weldment Bulletin 7001 or for specific information on how we may be of service to you, write to B-L-H Corporation, Philadelphia 42, Pa.

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Eddystone Division

Philadelphia 42, Pa.

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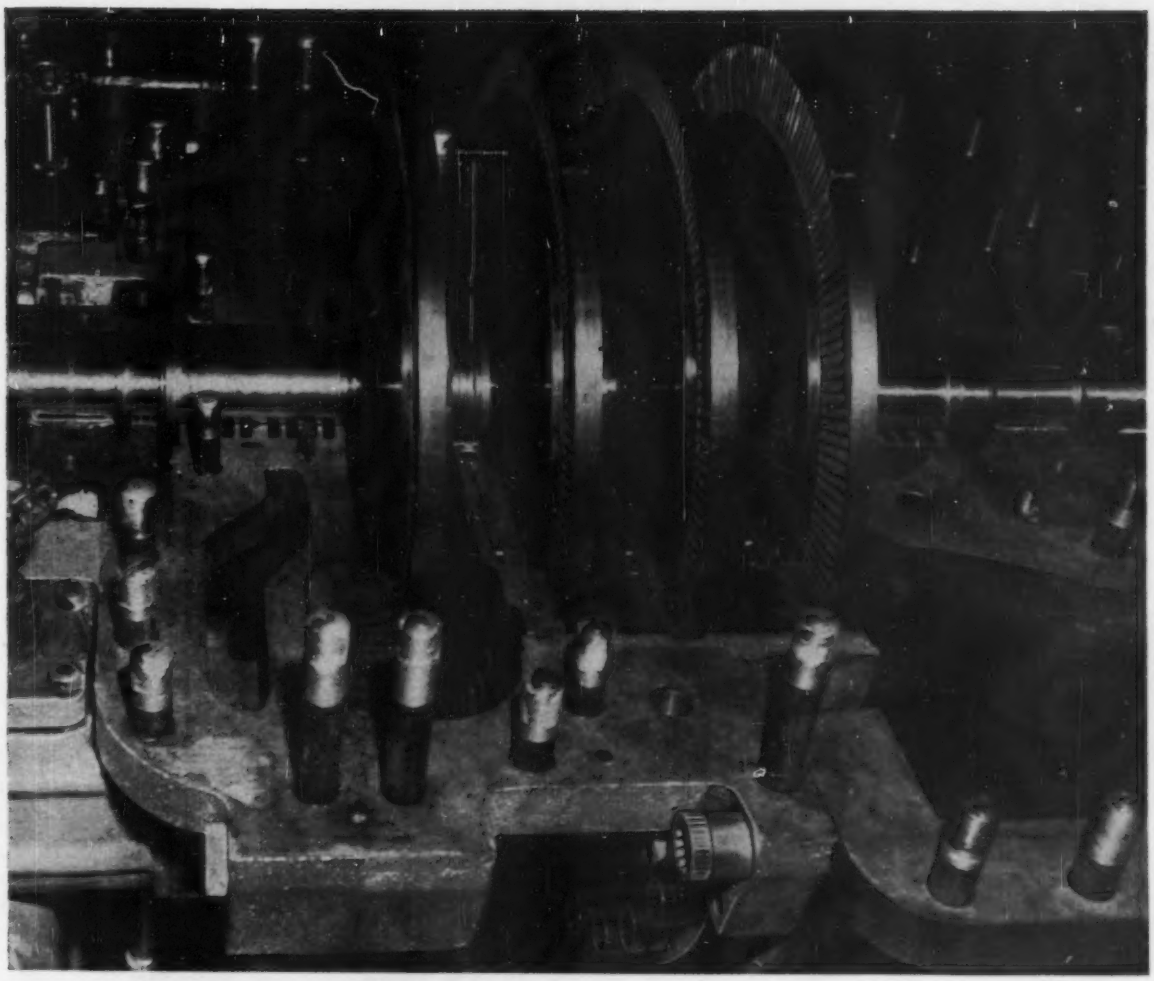

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Large-dimension disc rims receive the specially contoured stainless steel blades with the Murray integral shroud. This insures smooth steam passages with maximum strength.

Short bearing spans insure smooth operation and eliminate the hazard of operating in critical speeds.

A look at the heavy flanges and husky bolting in the actual unretouched shop photo shown above bears out the extreme ruggedness that typifies every feature of Murray construction.

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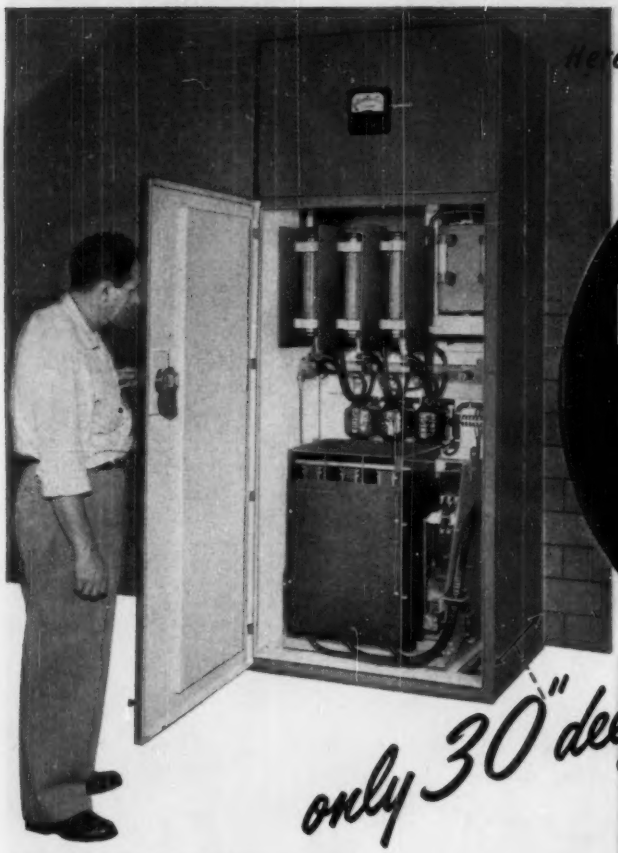

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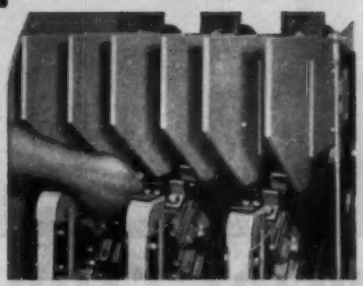

NO DRAW-OUT NEEDED • Arc shields slide out horizontally, making front and rear contact-tips removable with standard wrench.

Accessible from Front...

(Solid back) • Starters may be mounted against wall or in double row, back to back

EC&M's door-and-disconnect interlocking system gives you 3-way padlocked safety. The gang-operated Disconnect Switch may be padlocked (1) in the "ON" position or (2) in the "OFF" position—both with the starter door closed. (3) The door opens only by backing out captive thumb screws after the contactor and disconnect are open. For COMPLETE SAFETY—Disconnect Switch blades engage grounding clips in the open position.

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EC&M starters are furnished with a control transformer. Since the bus is located in an isolated upper compartment, only one feeder is required for a group of starters.

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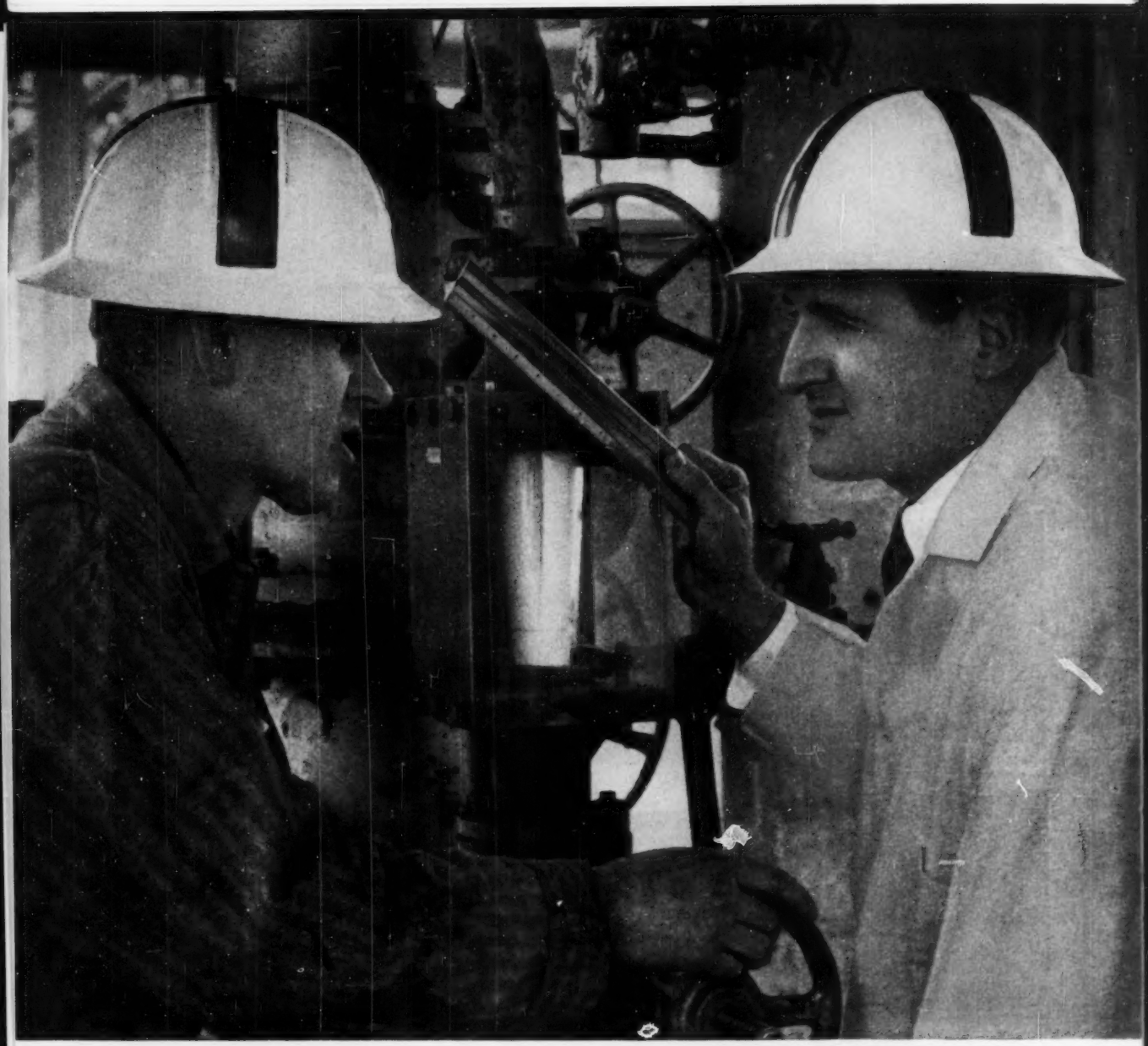

Photo taken at Delaware Refinery, Tidewater Oil Company

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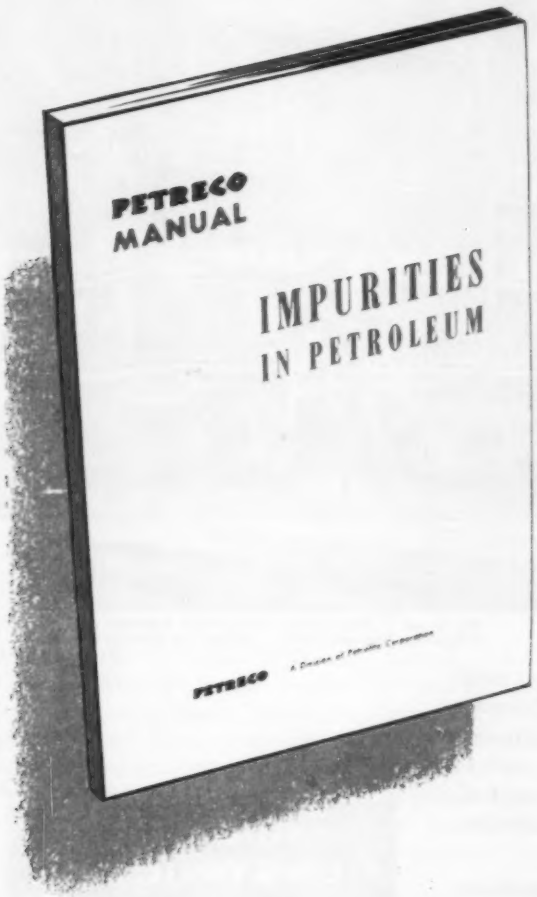

THIS TECHNICAL MANUAL is an up-to-date summary of impurities commonly found in petroleum and its products, especially as related to their significance in refinery operations. It contains the results of Petreco's extensive research on the subject, as well as the latest contributions from others in the industry. Part I describes how these impurities are affecting refinery operations where new processes, especially of the catalytic variety, have in recent times tended to disproportionately increase their harmful effects. The growing demands to produce maximum yields and premium products make this topic an increasingly important one. Part II presents a series of selected and tested analytical methods applicable to the evaluation of processes designed for the removal of these impurities.

Here are just some of the topics discussed in this informative new edition:

PARTIAL TABLE OF CONTENTS

THE NATURE OF PETROLEUM IMPURITIES • *Oleophobic impurities* • *Oleophilic impurities* • *Impurity residues from chemical treatments.*

SELECTED ANALYTICAL METHODS • *Sampling* • *Water Contents of Oils* • *Carry-over from Chemical Treatments* • *Salts in Crude Oils* • *Direct Determination of Chlorides* • *Phenols, Thiophenols, Mercaptans, Sodium and Free Sulfur in Distillates* • *Fouling Test for Settled Alkylates* • *Water Reaction Test for Aviation Fuels, etc., etc.*

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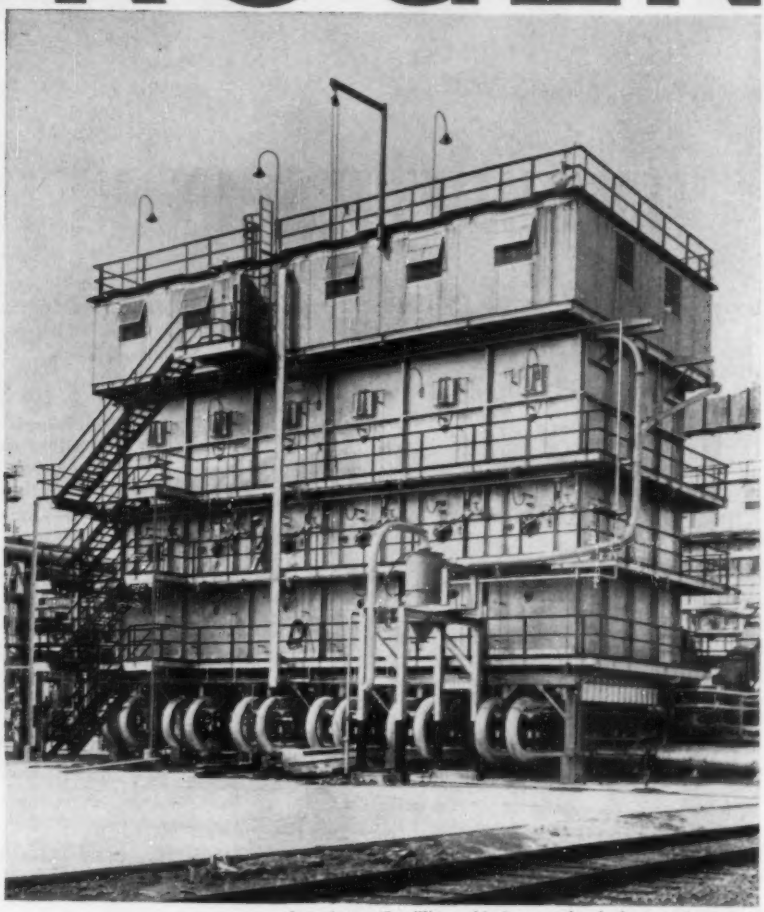

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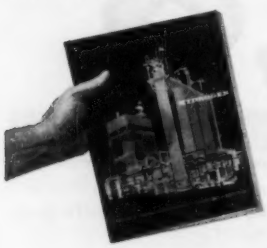

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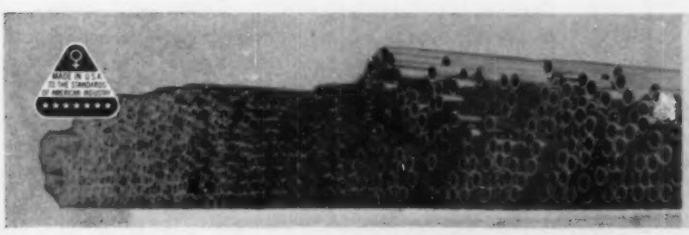

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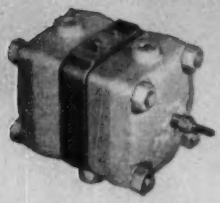
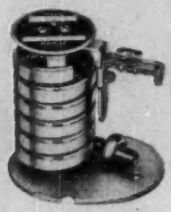
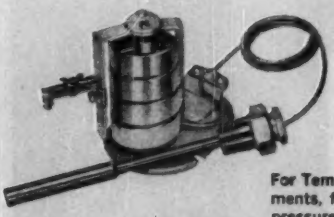


For Flow and Liquid Level — Type 37 Mercuryless Diaphragm Element. Ranges from 20 to 200 inches water.



For Pressure — Helical Elements, with ranges from 0-200 to 0-6000 psi. Ranges from 10 inches water to 80,000 psi available with other Foxboro pressure elements.



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Electronic Transmitter measures flow, pressure, temperature, level, and other variables. Provides local measurement indication directly from the primary element — completely independent of electrical components and power supply. Transmitter uses any standard Foxboro measuring element. No tubes — solid-state components used throughout.

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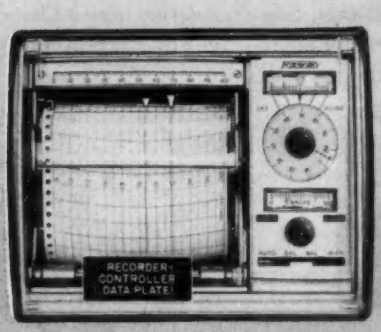

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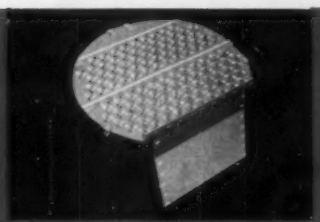

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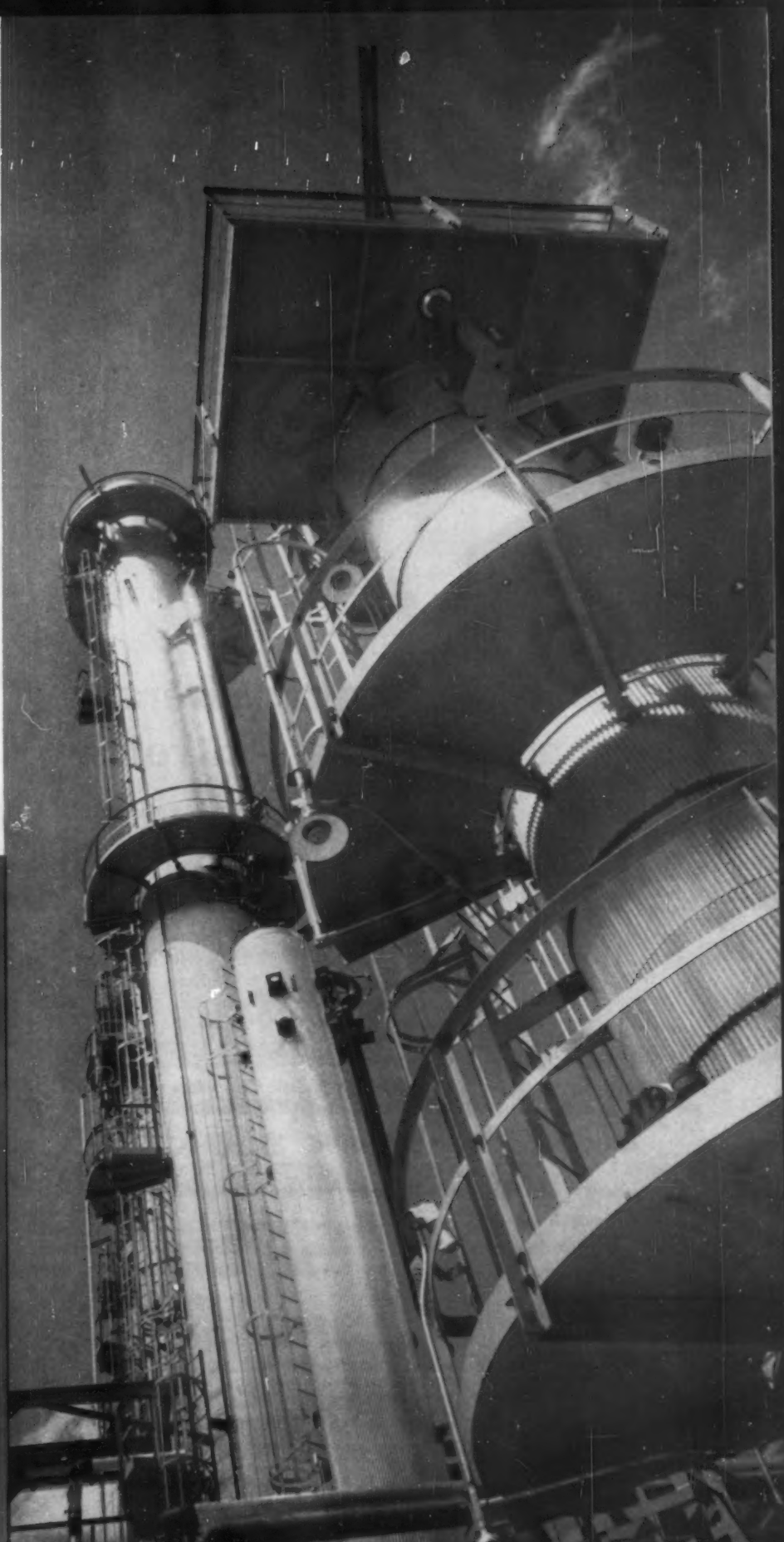

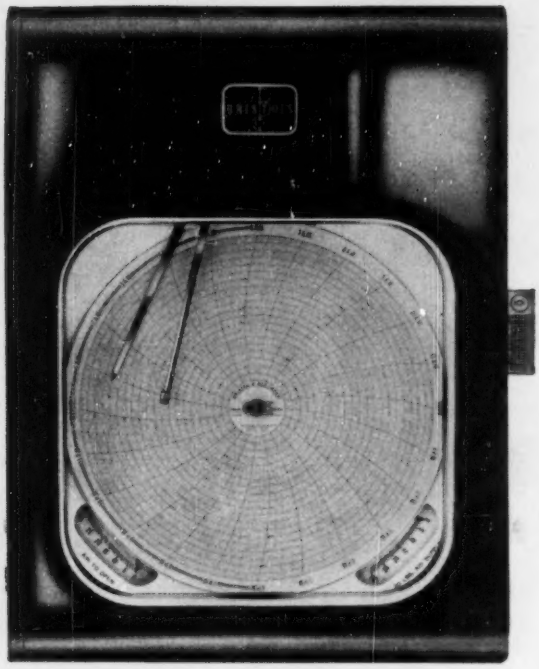

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These problems:	These operating modes:
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3. Ratio control	3. Reset with wide band—to 400%
4. Time program control	4. Derivative (rate)
5. Pneumatic Transmission	5. Reset plus derivative

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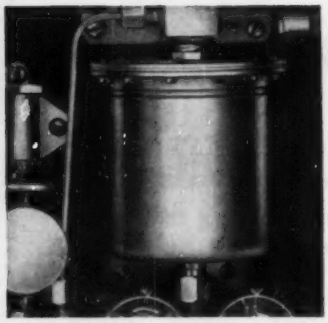
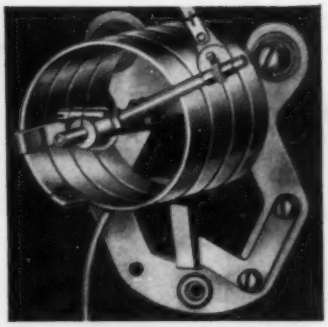
AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

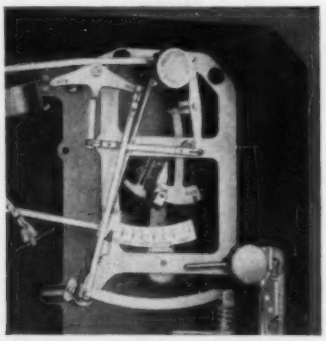


Reset Action Stops (in cylinder), another Bristol exclusive on reset models.

Zero Derivative Setting, exclusive with Bristol on derivative models.

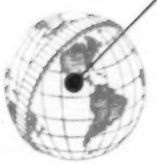


Precision Bristol Measuring Elements insure accuracy.



Built-in Calibration assures permanent accuracy of controller action.

MEMO



Approximate Service Limit	Brand
3200°F.	Castolast (Castable)
3100°F.	H-W High Alumina Castable
	Apache (Plastic Fire Brick)
3000°F.	Chromepak (Casting Mix)
	H-W Super Plastic Fire Brick
	Apache G (Plastic Fire Brick with Graphite added)
2900°F.	H-W Black Patch (Plastic Fire Brick)
2800°F.	Harcast (Castable)
2700°F.	H-W Super Castable
2600°F.	H-W Lightweight Castable 2600
	Harchrome (Castable)
	H-W Chrome Castable
2500°F.	H-W Standard Castable
	H-W Periklase Castable
	H-W Baffle Mix (Castable)
2400°F.	H-W Extra Strength Castable
2300°F.	H-W 85 Lightweight Castable
2200°F.	H-W 56 Low Iron Castable
	H-W 56 Lightweight Castable
1800°F.	H-W 25 Lightweight Castable
1500°F.	H-W Castable RC

The complete series of HARBISON-WALKER PLASTIC and CASTABLE REFRACTORIES

can assure the proper selection for maximum life and economy

In addition to the wide range of service temperature limits as here illustrated, these monolithic refractories possess the many different combinations of physical and chemical properties needed for best protection against widely diversified destructive factors. From these brands the best balanced selection can be made for adequately withstanding the most severe operating conditions. Some examples of the many destructive influences against which maximum resistance is needed, are: corrosion by slags, fuel ash and various other fluxes; thermal shock; disintegrating action of gases; erosion by molten metals and slags; mechanical stresses at the high working temperatures.

To help secure maximum service from these refractories, Harbison-Walker freely offers engineering service, recommendations based upon wide experience, and quality-controlled products.

HARBISON-WALKER REFRACTORIES CO.
AND SUBSIDIARIES GENERAL OFFICES: PITTSBURGH 22, PA.
World's Most Complete Refractories Service

TYPICAL FURNACE APPLICATIONS: ARCHES • ASH PITS • BOILER SETTINGS • BREECHINGS • BURNER BLOCKS • BAFFLES • CATALYTIC REACTORS • DOOR LININGS • DUCTS AND PIPING • HEARTHS • INSULATION • KILNS AND CARS • LADLE LININGS • ROTARY KILN CHAIN SECTIONS • SOAKING PIT COVERS

WHERE THERE'S BUSINESS ACTION THERE'S A BUSINESSPAPER

In any kind of racing—man, beast, or automotive—the "inside track" is the favored position.

Same holds true in the business race. But here the "inside track" means having more information—sounder information, more complete information, more timely information.

The astute businessman—the man on top and the man on the way up—gets that information from the businesspaper he subscribes to in his particular field. He reads for profit, not for pleasure. He searches for facts he needs to make decisions. For fresh ideas. For new methods. For new products he can put to work. He reads, in short, to get the "inside track" against competition.

And he finds much of what he wants and needs in the advertisements in his businesspaper. So, logically, he reads the advertising with the same scrutinizing care he devotes to the editorial pages.

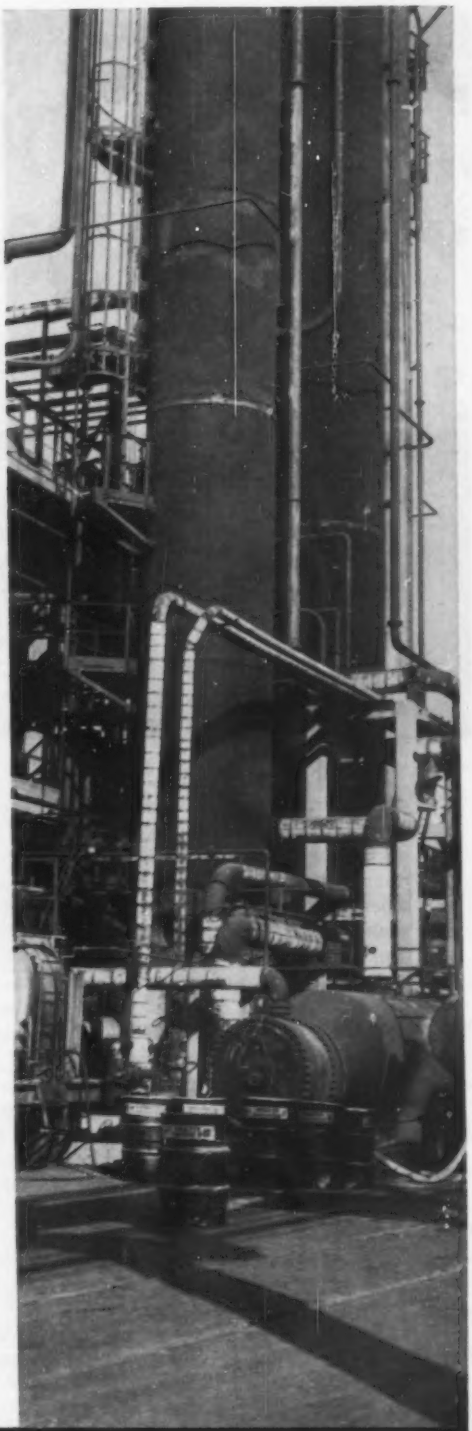
Take a tip from the man on the move who wants to keep his job and his business *moving*—on the "inside track." Subscribe to your businesspaper. Read every issue. Carefully. Thoroughly. Searchingly.

PETROLEUM REFINER

One of a series of advertisements prepared by THE ASSOCIATED BUSINESS PUBLICATIONS

Oakite ECP
engineered cleaning program

cuts turnaround to 32 hours, saves 75% in costs



Its ⅛" tray perforations nearly choked with scale, a 40-foot, 12 tray absorber tower needed thorough cleaning in the worst way. The trouble was time. The last cleaning, by hand, had taken 5 days and $3000.

Refinery engineers called in the Oakite man for an ECP. For this particular job he prescribed an Oakite solvent-acidic type cleaner—one that would remove not only caked-on carbon but sulphur and iron oxides as well. Results: tower cleaned in 32 hours at a cost of $750. Savings in turnaround time—3½ days! Savings in cost—$2,250.

WHAT IS OAKITE ECP? ECP stands for *Engineered Cleaning Program*. It's a program of chemical cleaning developed for your refinery, your equipment, your conditions, your throughput. It itemizes the problems, and the methods and materials to solve them. It puts the chemistry of cleaning to work for your benefit. It's supervised by a refinery-experienced Oakite engineer. Before you plan your next turnaround, call the Oakite office nearest you, or send for Bulletin F10102. Oakite Products, Inc., 50B Rector Street, New York 6, N.Y.

OAKITE
SPECIALIZED INDUSTRIAL CLEANING
MATERIALS · METHODS · SERVICE
SCIENCE

In our 50th year.

Export Division Cable Address: Oakite

Technical Service Representatives in Principal Cities of U. S. and Canada

Oakite ECP
your economy key

For more data on advertised products, use Readers' Service Cards, last page.

2 way safety + speed of operation

First, LimiTorque provides complete safety to workmen by eliminating the need for climbing to high, out of the way or hazardous locations for manual operation of valves. Second, LimiTorque protects valve operating parts by a torque limit switch which instantly shuts off the motor if obstructions are met during operation.

IT PAYS TO CONVERT YOUR HAND OPERATED VALVES TO LIMITORQUE MOTORIZED OPERATORS,—because valves are opened and closed at just the correct speed desired—dependably and safely.

Thousands of LimiTorque Valve Operators are used throughout the World, under all services and climatic conditions—by the "mere push of a button".

LimiTorque is backed by 26 years experience and continuous use,—and may be actuated by any available power source, such as Electricity, Oil, Gas, Air, or Water.

So, again we say convert your hand operated valves to LimiTorque and save time, trouble, labor, and money.

For further information, contact your Valve Manufacturer, or call your nearest LimiTorque Sales Engineering Office.

LimiTorque is, by far, the most widely used valve operator in the World . . . Send for complete Catalog L-550, on your Business Letterhead.

THERE IS NO SUBSTITUTE FOR —

LimiTorque®

PHILADELPHIA GEAR CORPORATION

ERIE AVE. & G STREET, PHILADELPHIA 34, PENNA.

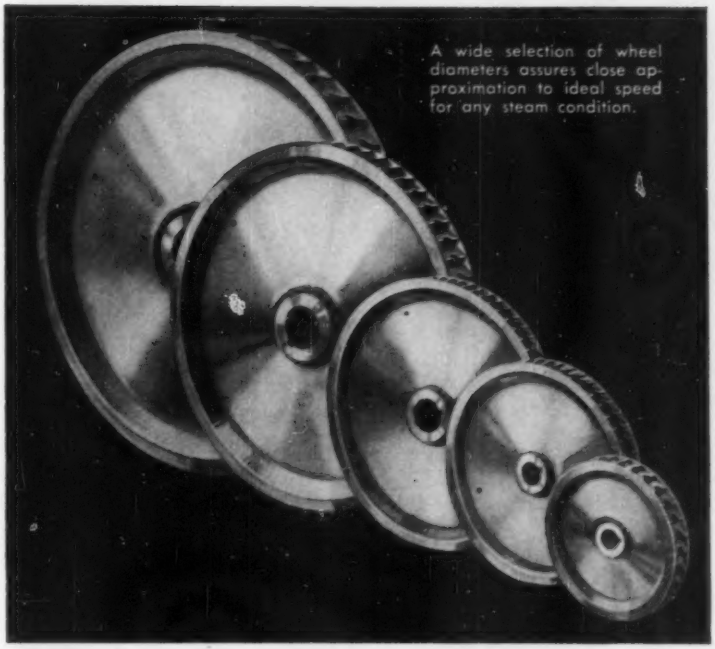
Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID AGITATORS • FLEXIBLE COUPLINGS

Limitorque Corporation • Philadelphia

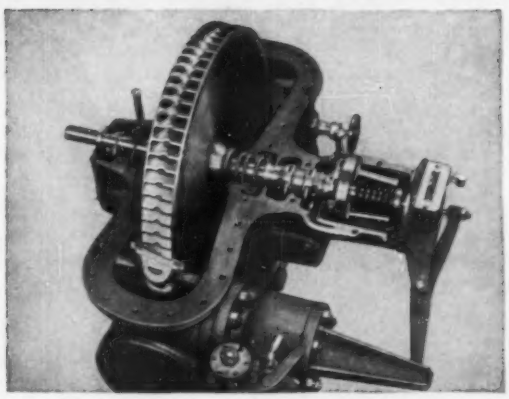
There's a TERRY wheel turbine to meet your specific needs!

SOLID-WHEEL DURABILITY COMES IN ALL SIZES...



A wide selection of wheel diameters assures close approximation to ideal speed for any steam condition.

Terry wheel turbine with cover removed to show the solid wheel. There are no separate parts to loosen or work out. Blade clearances are generous.



up to 2000 HP

Wherever you need dependable turbine drive up to 2000 HP—and strength and durability are major factors—Terry solid-wheel turbines are specifically equipped for the job. For, within their simple, sturdy casing is a rugged one-piece wheel.

You choose from a broad selection of sizes for all mechanical drive applications—with each Terry wheel turbine accurately proportioned to fit the operating conditions. From the smallest to the largest, these rugged turbines have:

- Solid one-piece wheel.
- Large radial and axial clearances.
- Double rim protected blading.
- Individual nozzle control.
- Dependable and durable governor.
- Heavy dust-proof bearing and governor housing.
- Independent overspeed trip with separate valve.
- Sturdy casing design.
- Strong and easily inspected steam strainer.
- Truly accessible construction, which makes inspection of the interior parts a simple matter.

For full details, send for a copy of bulletin S-116.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1208

For more data on advertised products, use Readers' Service Cards, last page.

For your next project... avail yourself of
PRACTICAL
EXPERIENCE
Your industry is increasingly reliant upon process engineering procedures learned for others. The engineering staff of Stearns-Roger has these resources because of the many areas in which Stearns-Roger is continually engaged: metallurgy, power, atomic energy, chemical processing, and oil and gas processing. These men are ever alert to new designs for more efficient plant arrangement or operation.
Stearns-Roger has for years been closely identified with the oil and gas industry. Processing plants designed and built by Stearns-Roger operate from the extreme cold of Canada to the mild conditions of the Texas Gulf, ranging from the very large to the very small.
Starting with analysis of well-head gas, S-R facilities are complete for handling each successive step through process design, general engineering, fabrication of special equipment in our shops, and field installation with our own personnel. We deliver a completed plant, operating, to meet the customer's long term needs.
Stearns-Roger
THE STEARNS-ROGER MFG CO. • DENVER, COLORADO
DENVER • HOUSTON • EL PASO • SALT LAKE CITY
Stearns-Roger Engineering Company
Calgary, Alberta

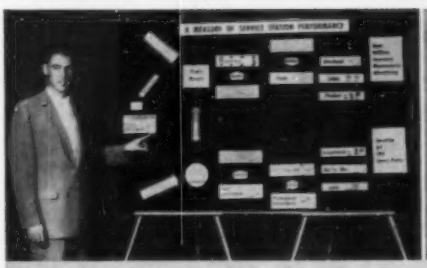
For more data on advertised products, use Readers' Service Cards, last page.

DU PONT *Petroleum Chemicals* NEWS

Number 93 in a Series of Bulletins for the Petroleum Industry

DECEMBER 1958

Three oil industry presentations by DuPont win first-place awards for effectiveness



"A Measure of Service Station Performance"

"What Every Woman Should Know About Her Car"

"Dollars and Sense"

TOPS FOR TRAINING: Du Pont presentations for the oil industry which won first prizes in 1958 visual aids competition

Three training presentations widely used in the petroleum industry have won first-place awards in the 1958 visual aids contest of the National Visual Presentation Association.

Created as part of the Du Pont sales and service program for refiners and marketers, these prize-winning presentations topped all others in three of the six categories in the Graphics competition.

All three prize-winning programs are available to oil companies for dealer orientation, service station training, or good-will showings to groups of consumers.

"*A Measure of Service Station Performance*" won first place in the "Employee Training" category.

It is a flannelboard presentation created to simplify and explain the economic factors which realistically measure the success of a dealer in terms of "per cent return on investment." It can be given as a three-hour discussion program, or as two 1½-hour sessions, or in short form as a 30-minute lecture. The longer versions include the use of a worksheet which helps each member of the audience to measure his own performance.

"*What Every Woman Should Know About Her Car*" took first-place honors in the "Public Relations – Education" class.

This "flackboard" (flannelboard and blackboard combined) presentation was created to increase greatly the public's confidence in their service station operators. It explains in simple terms the mechanical features of the modern automobile, and tells how women can keep their cars operating dependably with the help of their dealers' knowledge. It tells what must be attended to – why – and when, and convincingly shows that the cost of this regular maintenance is much lower than various types of insurance – only about 7/10¢ per mile.

"*Dollars and Sense*" is a flannelboard presentation which explains the everyday problems of all businesses – large and small. It won first prize in the "Employee Relations" category.

Oil helps make Christmas merrier for millions

Many of oil's chemical offspring will play a big part in making Christmas a happy occasion around the world this year.

Nylon, for example, will find its way under millions of Christmas trees – as molded parts in *Junior's train*, in *Dad's power tools*, and in an infinite variety of garments from *stretch socks* to *dolls' clothes*.

"Dacron" polyester fiber, another product made partly from oil, will turn up in everything from *shirts* to *slacks*, *loungewear* to *lingerie*.

And many, many more products derived from oil will contribute to happiness at Christmas this year.

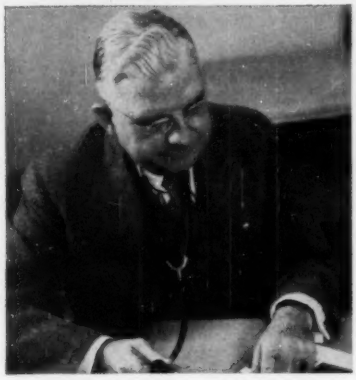
These products are the results of constant experimentation and research, with oil and its derivatives. At Du Pont, chemistry helps turn oil into exciting new products. This spells an ever increasing demand for petroleum in the years to come.

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DUPONT *Petroleum Chemicals* NEWS

You ought to know...



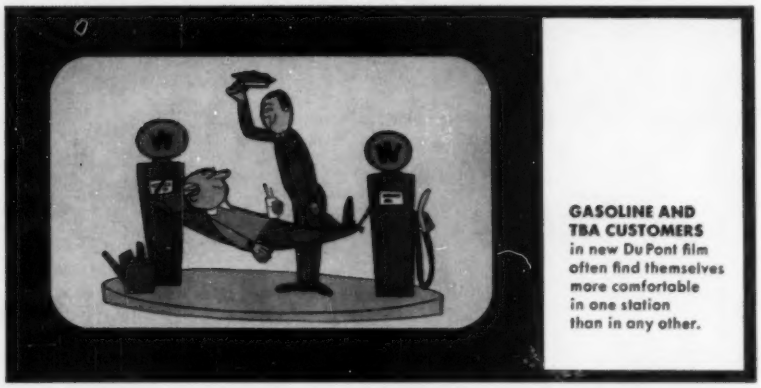
FENTON RUSSELL, M.D., has, by his own admission, "not discovered anything and has invented nothing."

Yet as a member of DuPont's Medical Division, Dr. Russell plays a role that is of importance to every refiner who uses tetraethyl lead. Travelling distances which would amaze the busy circuit-riding doctor of the past, he works closely with refinery managements, physicians, supervisors and blenders to help them maintain the very finest health and hygiene programs.

Dr. Russell also participates in many of the DuPont Training Programs conducted in refineries, to teach safe and proper methods of unloading and blending tetraethyl lead.

He joined the DuPont Company in 1943 and participated in the wartime Manhattan Project at Hanford, Washington. Later he moved to the DuPont Medical Division to pursue his special interests, Legal Medicine and Toxicology. Dr. Russell received both his B.S. and M.D. degrees from the University of Pittsburgh.

His friends know that he "loves to make a speech" – which should lend encouragement to refiners who might want to use the services of Dr. Russell to augment their own safety training programs.



GASOLINE AND TBA CUSTOMERS in new DuPont film often find themselves more comfortable in one station than in any other.

"Know your customer" motion picture helps dealers use psychology in selling

"Gee . . . he picked my station!" enthuses the typical service station operator, in DuPont's new full-color semi-animated strip-film.

Then he learns *why* his customers choose him . . . what makes a customer tick. The information in this 10 minute presentation is based on the nationwide survey of service station patrons which was conducted for DuPont by psychologists from National Analysts, Inc.

In the survey–and in this screenplay – the *real* reasons for station selection are revealed. For example, the patron who drives past station after station across a city to go to his favorite dealer's because it is "convenient" is actually motivated by his feeling that this particular dealer is really interested in him and his car.

And the woman who goes to a station "because it is convenient" often has an even deeper reason – in some service stations she is treated with patience and helpfulness, not being made to feel uncomfortable in a strange man's world of mechanical mysteries.

This sound film, with its likeable characters and sprightly action, carries its message simply, with force and good humor. It is ideal for dealer-orientation meetings, for which it is readily available. Simply contact your DuPont representative and he will arrange showings for you.

SALES OFFICES

Chicago 3–8 So. Michigan Ave. . . RAndolph 6-8630
Cleveland 15–101 Prospect Ave. . . . . MAin 1-3422
Houston 2–705 Bank of Commerce Bldg. . . . . CApitol 5-1151
Los Angeles 17–612 So. Flower St. MAdison 4-1354
New York 20–45 Rockefeller Plaza . . . . . COlumbus 5-2342
Philadelphia 2–3 Penn Center Plaza . LOcust 8-3531
Pittsburgh 22–1 Gateway Center . . ATlantic 1-2933
San Francisco 4–111 Sutter St. . . . EXbrook 2-1934
Seattle 3–4003 Aurora Ave. . . . . MElrose 2-6977
Tulsa 1–1811 So. Baltimore Ave. . . . LUther 5-5578
In Canada–DuPont Company of Canada (1956) Limited, Petroleum Chemicals, 85 Eglinton Ave. East, **Toronto 12**–Ontario . . . . . HUdson 1-6461
In Other Countries–Organic Chemicals Department, Export Division, 7447 Nemours Bldg., Wilmington 98, Del., PRospect 4-2962.

CONTINUED

First Place Awards

Purpose of this visual aid is to help improve relationships between oil companies and dealers, by helping dealers to understand our free enterprise system in the light of problems shared by business of all sizes, with some predictions about the future of the service station business.

Kits for these presentations are available, complete with detailed scripts. Any speaker can use them with a minimum of preparation.

For further information about these –or the more than 30 other sales services we offer–write to Petroleum Chemicals Division of the DuPont Company.

DUPONT
REG. U.S. PAT. OFF.

Better Things for Better Living
. . . through Chemistry

Du Pont Tetraethyl Lead and other Petroleum Additives

OVER

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

A-8416

Printed in U. S. A.

ENGINEERS "DISCOVER" ALCOA CONDUIT

Lower cost, installation economies, corrosion resistance make Alcoa Aluminum the best conduit buy

An increasing number of cost-conscious engineers are switching to aluminum rigid conduit for office buildings, industrial plants and other new and remodeled structures. Here are some of the reasons why:

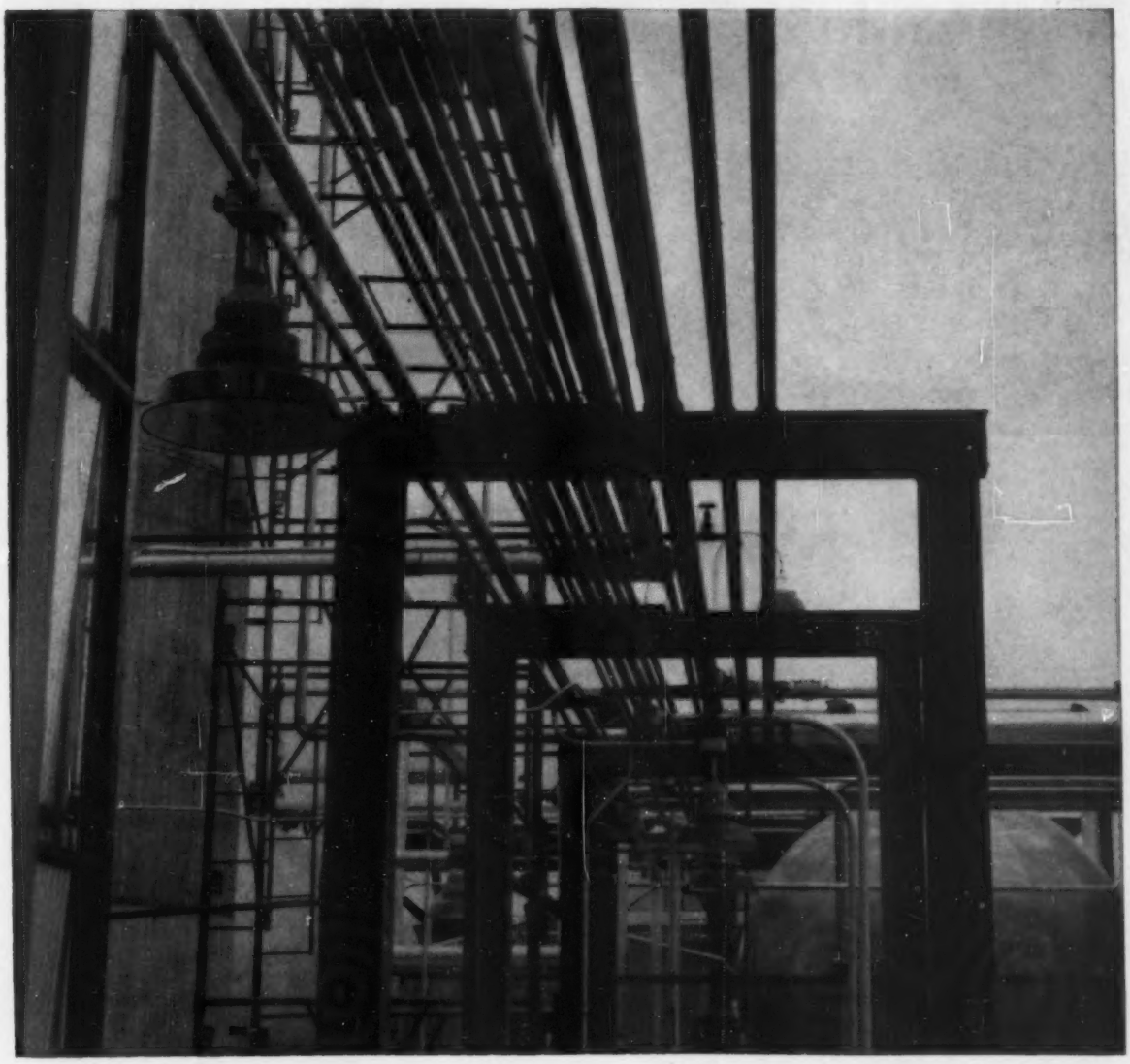
- Lower prices plus light weight and ease in handling make Alcoa® Aluminum Conduit installations competitive.
- Corrosion resistance of aluminum means less maintenance, freedom from staining.
- Aluminum is easier to cut, bend and thread. Wire pulling is easy, too, because of specially treated internal surface.
- Nonmagnetic aluminum offers up to 20 per cent less voltage drop.
- Clean, modern appearance complements modern architecture.
- Aluminum is nonsparking and has Underwriters' Laboratories, Inc., approval.

Find out why Alcoa Aluminum is your best conduit buy. Contact your electrical distributor, or write Aluminum Company of America, 2325-M Alcoa Building, Pittsburgh 19, Pennsylvania.

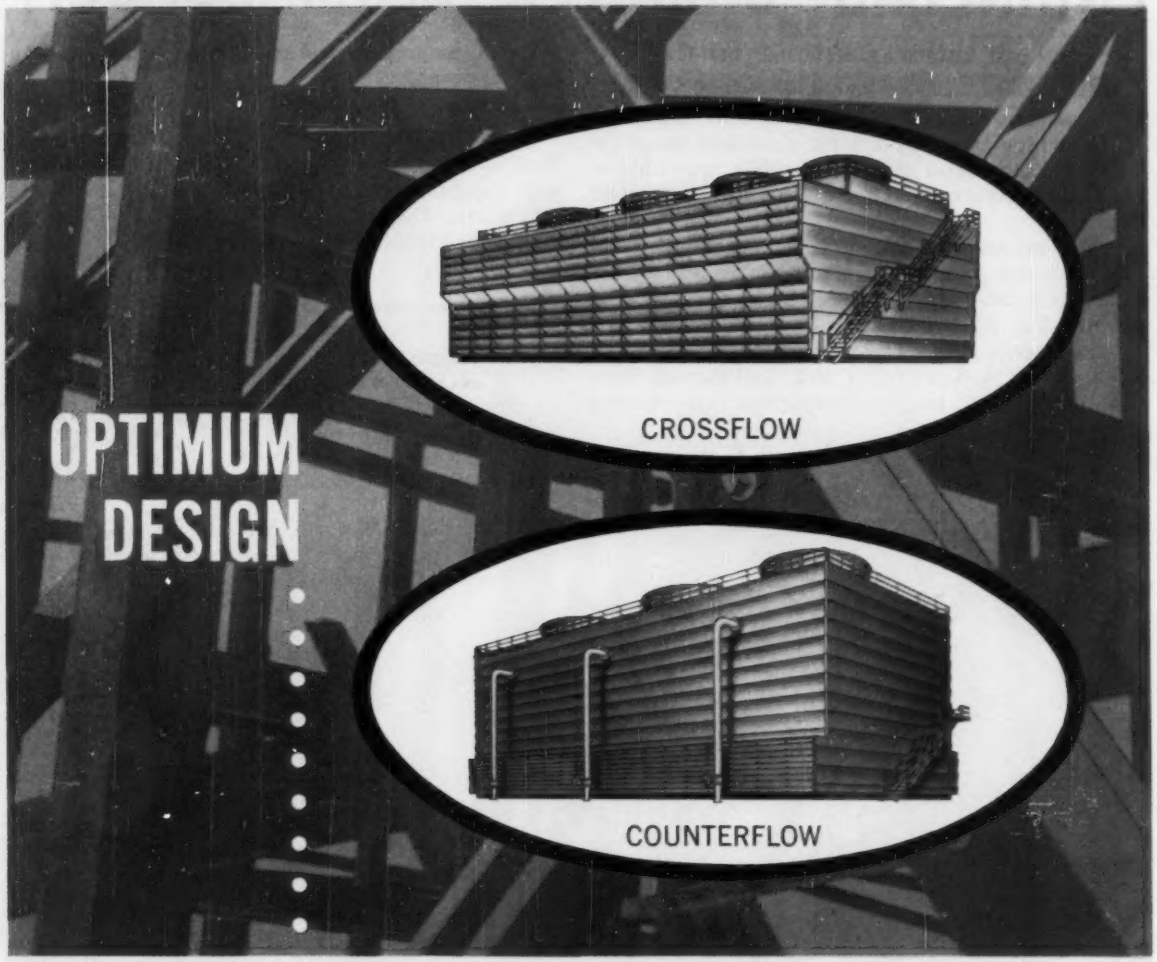
Your Guide to the Best in Aluminum Value

ALCOA THEATRE
Fine Entertainment
Alternate Monday Evenings

The Texas Company, Lockport, Illinois



For more data on advertised products, use Readers' Service Cards, last page.



produces important savings in

COOLING TOWERS

Optimum designing of a cooling tower economically balances universally available substances—wood, air and water—into the most effective combination for achieving the results desired.

Basic to this is complete familiarity with the distinctly different fields of application of the two types of towers—CROSSFLOW and COUNTERFLOW—plus the ability to analyze process requirements impartially and objectively.

Slough-De Flon is the only designer and manufacturer of a complete line of industrial cooling towers to offer both types.

To learn more about optimum design—and for a discussion of the fields of application of the two types of towers, write for a free copy of our new brochure, "Cooling Tower Versatility." There is no obligation.

S/D

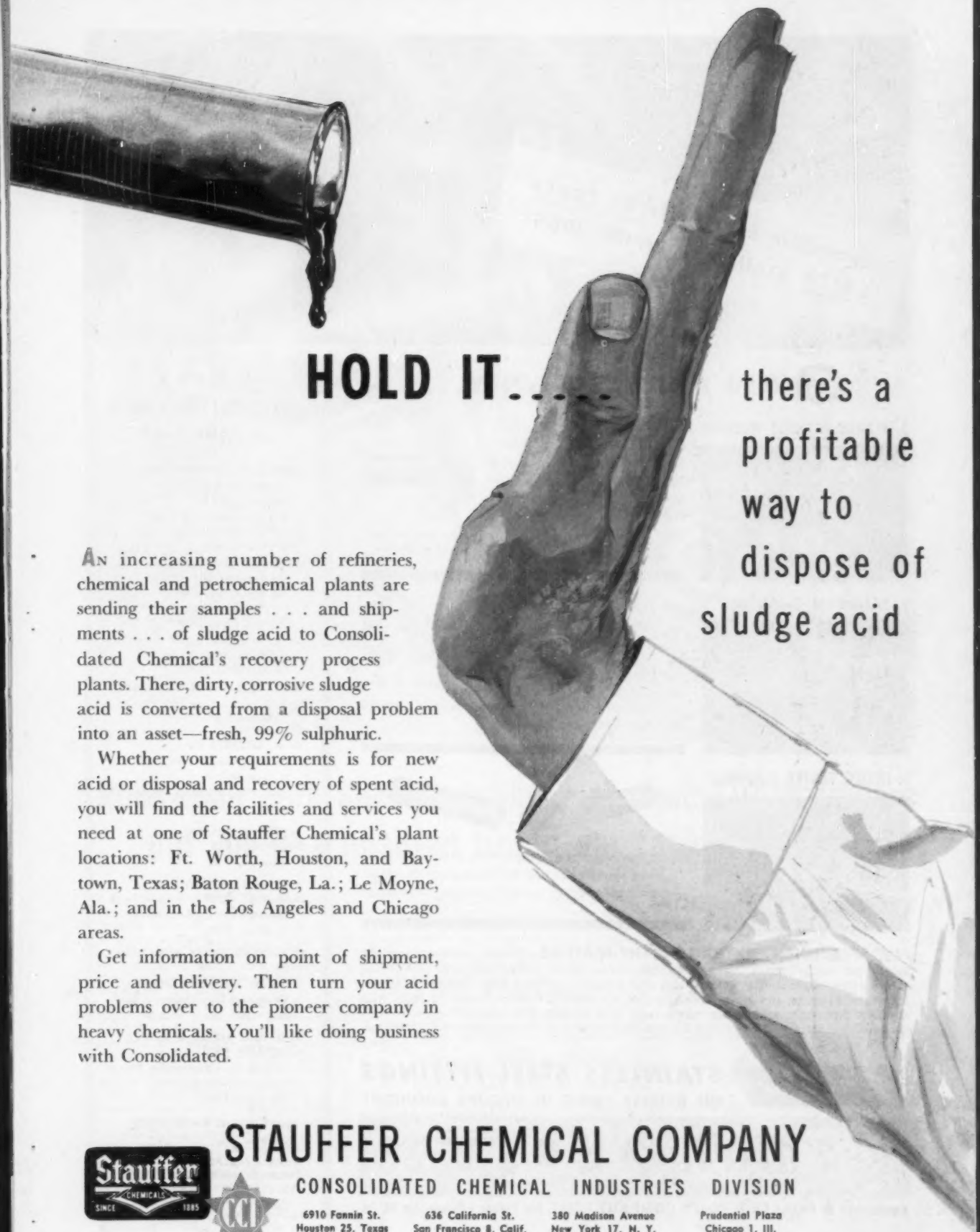
SLOUGH-DeFLON

COOLING TOWER ENGINEERS

2445 HUNTINGTON DRIVE, SAN MARINO, CALIFORNIA

REPRESENTATIVES IN ALL MAJOR AREAS

For more data on advertised products, use Readers' Service Cards, last page.



HOLD IT.....

there's a profitable way to dispose of sludge acid

AN increasing number of refineries, chemical and petrochemical plants are sending their samples . . . and shipments . . . of sludge acid to Consolidated Chemical's recovery process plants. There, dirty, corrosive sludge acid is converted from a disposal problem into an asset—fresh, 99% sulphuric.

Whether your requirements is for new acid or disposal and recovery of spent acid, you will find the facilities and services you need at one of Stauffer Chemical's plant locations: Ft. Worth, Houston, and Baytown, Texas; Baton Rouge, La.; Le Moyne, Ala.; and in the Los Angeles and Chicago areas.

Get information on point of shipment, price and delivery. Then turn your acid problems over to the pioneer company in heavy chemicals. You'll like doing business with Consolidated.

Stauffer CHEMICALS SINCE 1885

CCI

STAUFFER CHEMICAL COMPANY

CONSOLIDATED CHEMICAL INDUSTRIES DIVISION

6910 Fannin St. Houston 25, Texas

636 California St. San Francisco 8, Calif.

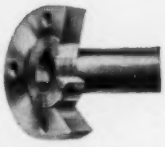
380 Madison Avenue New York 17, N. Y.

Prudential Plaza Chicago 1, Ill.

3 BIG REASONS WHY...

1. FLANGE WITHOUT WELDING

Faster than welding... *easier* than welding. A Speedline Insert Flange assures a leak-proof, *expanded* joint *every* time. Saves assembly time *and* costs!



Cutaway view shows pipe expanded into Insert Flange

2. LEAKPROOF UNION JOINTS

Speedline Unions are *gasket seated* to prevent leakage ... bi-metallic for easy make-up and disassembly without galling or seizing. Available in two types: PE for expanding or PW for welding to Sch. 5 or 10 pipe and Speedline Fittings.

Type PW—For Welding

3. EASIER, FASTER ALIGNMENT

Speedline Aligning Connectors fit *over pipe ends* ... save time in aligning the most complex layout —permit preassembly *prior* to welding or brazing!

***PLUS* SPEEDLINE'S "EXTRA LENGTH" FEATURE**—There's an extra straight section on *every* end of *every* Speedline elbow, tee, reducer, bend and cross. This means extra clearance for welding and also facilitates joining with flanges or unions. Speedline Fittings, designed especially for use with Schedule 5 and 10 light wall stainless pipe, offer installation advantages and other cost savings not possible with conventional fittings. Write today for Speedline catalog or contact nearest Distributor.

810

Speedline STAINLESS STEEL FITTINGS

THE NEWEST THING IN PIPELINE ECONOMY

Manufactured by HORACE T. POTTS COMPANY • 566 E. Erie Avenue • Philadelphia 34, Pa.

THERE'S A *SPEEDLINE* Distributor IN YOUR AREA

BROWN WALES COMPANY
Cambridge, Mass.
Auburn, Maine

THE CLEVELAND TOOL & SUPPLY CO.
Cleveland, Ohio

ELECTRIC STEEL FOUNDRY CO.
Los Angeles, Calif.
San Francisco (Emeryville), Calif.
Denver, Col.
Portland, Ore.—Seattle, Wash.

A. B. MURRAY COMPANY
Pittsburgh (McKeesport), Pa.
Elizabeth, N.J.

HORACE T. POTTS COMPANY
Philadelphia, Pa.—York, Pa.
Baltimore, Md.

C. A. ROBERTS CO.
Chicago (Franklin Park), Ill.
St. Louis, Mo.
Tulsa, Okla.—Indianapolis, Ind.
Kansas City, Mo.

SCHNITZER ALLOY PRODUCTS CO.
Elizabeth, N. J.

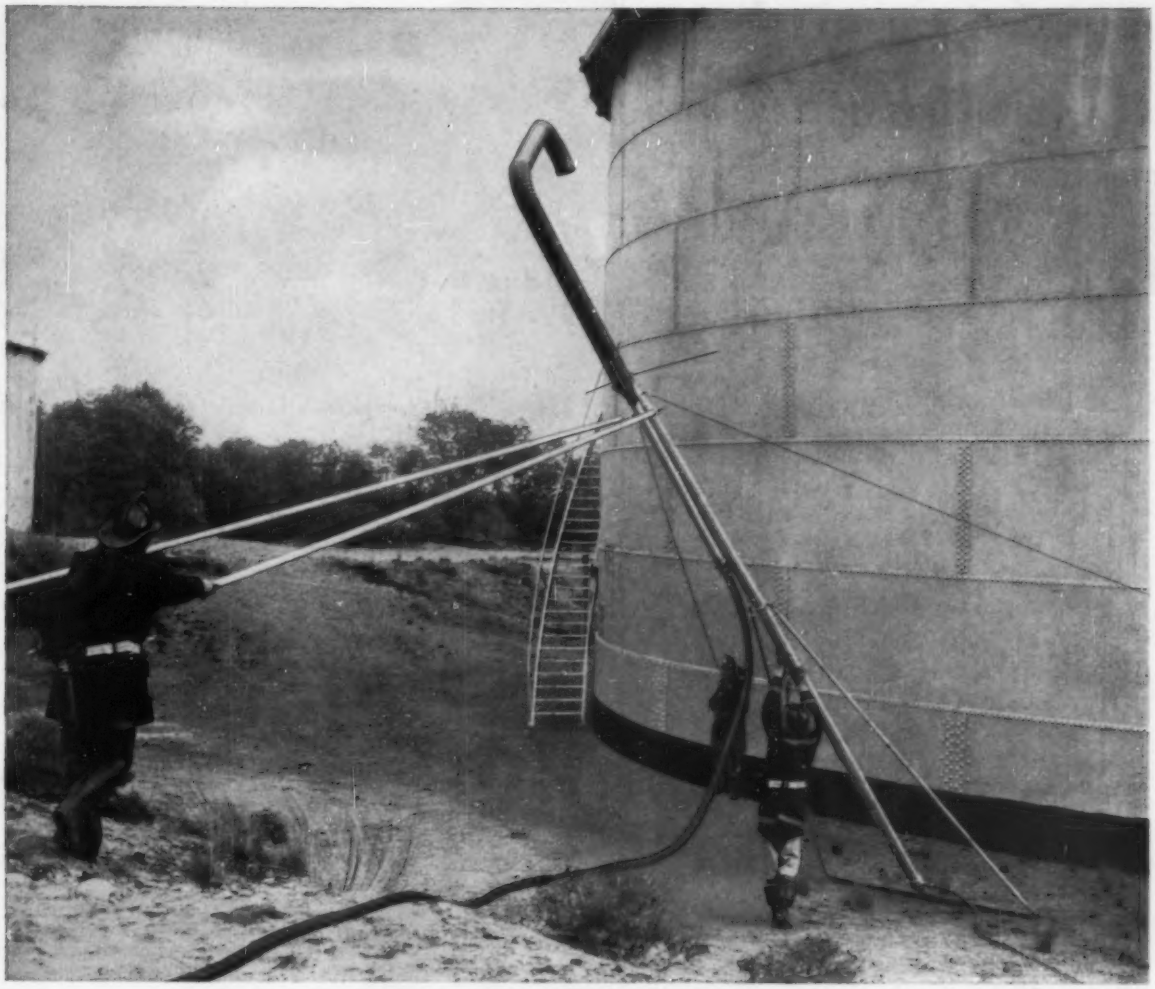
SERVICE STEEL DIVISION VAN PELT CORP.
Detroit, Mich.—Buffalo, N. Y.
Cincinnati, Ohio

STANDARD BRASS AND MFG. CO.
Houston, Tex.—New Orleans, La.
Shreveport, La.—Beaumont, Tex.
Port Arthur, Tex.

J. M. TULL METAL & SUPPLY COMPANY, INC.
Atlanta, Ga.—Jacksonville, Fla.
Miami, Fla.—Tampa, Fla.
Birmingham, Ala.

ALLOY METAL SALES LTD.
Canada

RAILWAY & POWER ENGINEERING CORPORATION LTD.
Canada



Rockwood Sure Shot Portable Telescopic FOAM Towers put you in a position to put out tank fires fast!

Lightweight! The tower columns, braces, and gin poles are made of lightweight, high strength aluminum alloys. Even the largest of the 4 towers (67') can be carried, fully assembled, to the erecting position by only 3 men. A crew of 5 can erect a tower and place a FOAM head in position in 5 minutes.

Hydraulically Operated! The FOAM tower column consists of a telescoping hydraulic ram that is elevated by water pressure. For extreme cold weather operation, a hydraulic kit is available that permits raising the tower by means of carbon dioxide or nitrogen pressure.

One Tower Places as Many as 4 Outlets! One tower puts several FOAM discharge outlets into position — making the Rockwood tower the equivalent of many conventional foam towers! A crew of 5 men can erect and install 4 FOAM heads in 17 minutes. And one tower can be used to place chemical foam outlets as well as mechanical foam types!

Minimum Care and Storage! The tower sections consist of three or four section hydraulic rams made of rust-proof aluminum. The lower tube has a heavy wall section to prevent physical damage. Towers retract to 20 ft. or less for ease in carrying on a fire truck or trailer.

Write for the full story!
Distributors in all principal cities.

ROCKWOOD SPRINKLER COMPANY

Engineers Water
. . . to Cut Fire Losses

ROCKWOOD SPRINKLER COMPANY
Portable Fire Protection Division
1306 Harlow Street, Worcester 5, Massachusetts

Please send me your illustrated booklet on Rockwood fire-fighting products, including your portable hydraulic tower.

Name.....

Title.....

Company.....

Street.....

City.....*Zone*.....*State*.....

For more data on advertised products, use Readers' Service Cards, last page.

Announcing

The New HORTON *Fabric* SEAL

NOW...a safe, tight seal for any Floating Roof

The new Horton Fabric Seal extends the "no vapor space" concept of a floating roof tank *all the way to the tank shell* . . . using a tough, long lasting fabric that conforms to any shell irregularity or tank out-of-roundness.

Recent development of this composite fabric now allows CB&I to bring into *practical* use a basic idea first patented by the Company in 1937.

Rigid service and laboratory tests have *proved* that the Horton Fabric Seal reduces evaporation losses to a minimum while providing safety and durability features never offered before by any fabric-type seal.

Contact our nearest sales office for complete information about the new Horton Fabric Seal, designed by CB&I with the "know-how" gained from 35 years of experience in building floating roofs.

Write our nearest office for your copy of the new *Horton Fabric Seal* brochure.

SAFE

- Interleafed galvanized sheets provide electrical bond between roof and shell
- Explosive mixtures directly above liquid are eliminated

DURABLE

- Product and abrasion resistant buna N on tough nylon fabric for long wear, tight seal
- Galvanized weather shield protects sealing band from reflected sunlight, rain, snow, etc.

SERVICEABLE

- Full protection for oxygen sensitive stocks
- All moving parts immersed as protection against corrosion
- Intimate contact to tank shell, including irregularities, for full travel of floating roof

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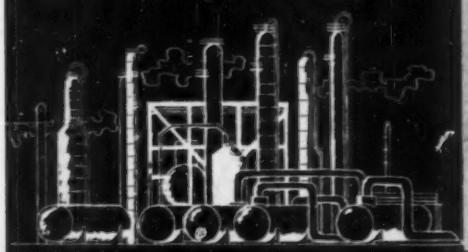
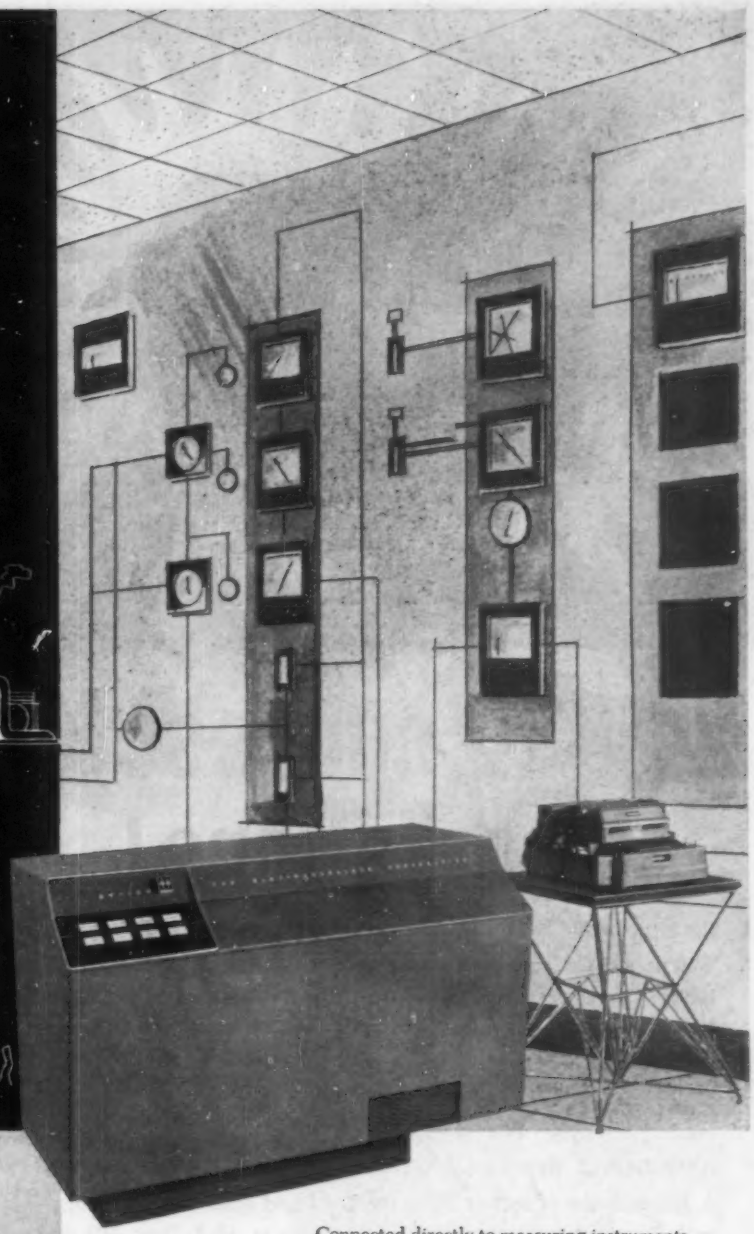
advanced data logging



...with the RW-300 digital control computer



The Ramo-Wooldridge RW-300 Digital Control Computer—the first digital computer designed specifically for automatic on-line process control and data logging—offers significant advantages as the heart of advanced data logging and scanning systems for oil refining, chemical, and other process industries. Unlike conventional data loggers, the RW-300 can be converted to completely automatic control through a minor field modification without purchasing expensive additional equipment and without scrapping any part of the existing logger.

Connected directly to measuring instruments, the RW-300 can do more than log raw or partially processed data. It can also compute and immediately print out more meaningful information such as yields, conversion efficiencies, and energy balances. The RW-300 can also calculate operating guides for plant personnel to follow. In addition to checking process variables against upper and lower limits, the RW-300 can perform more sophisticated checks on process equipment and the process itself. These checks reduce plant maintenance costs by detecting faulty operation of the process in time for corrective action.

For technical information on automatic process control and advanced data logging with the RW-300, write: Director of Marketing, The Thompson-Ramo-Wooldridge Products Company, P. O. Box 90067, Airport Station, Los Angeles 45, California, or call OSborne 5-4601.

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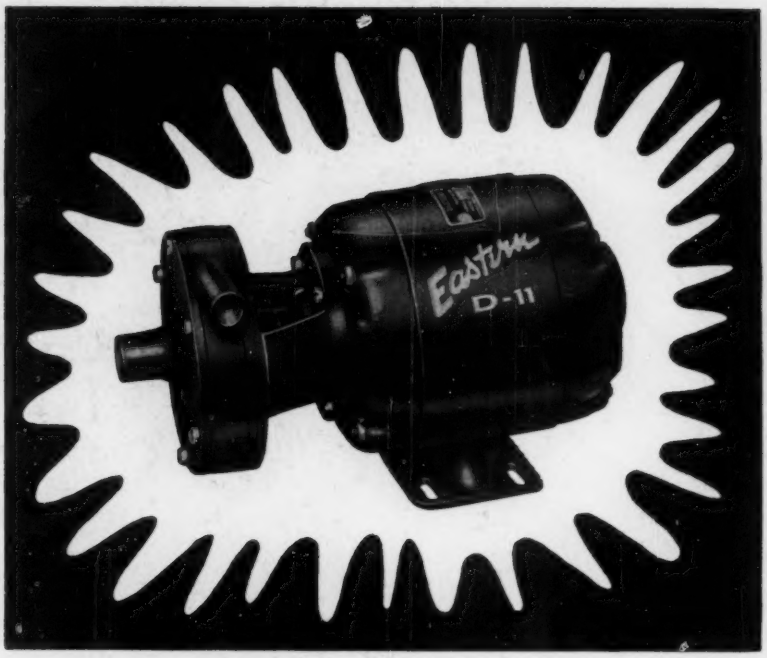
For more data on advertised products, use Readers' Service Cards, last page.



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A full selection of metals make the D-11 and other Eastern Centrifugal Pumps versatile performers. Available in 18-8 Type 303 and Type 316 Stainless Steel, Monel, Hastelloy "C", Cast Iron and Bronze, Eastern Pumps range from ⅙th to ¾ H.P. with capacities up to 70 G.P.M., pressures to 65 P.S.I.

For complete specifications on all Eastern Centrifugal Pumps, request Bulletin 120N

Eastern INDUSTRIES, INC.
100 Skiff St., Hamden 14, Conn.

The Mail Box . . .

Cites Omissions

To the Editor:

Upon publication of my article on Plant Layout in your October 1958 issue (page 109), I became aware of two unfortunate omissions in your comments "About the author . . . " on page 110. Firstly they failed to indicate my six years of experience with Bechtel Corporation, from which grew much of the background for the first third of the article, and secondly they did not indicate that my U. C. lecturing position was in the field of process engineering.

Apparently these omissions resulted from the fact that I was out of town at the time the information was furnished to you, and the typist was not entirely familiar with these details. Moreover, I was sent no proof to check on these points.

It would be greatly appreciated therefore if this letter could be included in "The Mail Box."

John F. McGarry
University of California,
Berkeley

No Punches Pulled

To the Editor:

I thought your article in the "Look Box" section of October, '58 Petroleum Refiner titled "It's Our Last Line of Defense" was excellent. Please continue to give your readers informative and factual material such as this so we might use it when writing our Congressmen. This editorial did not pull any punches. Congratulations.

I also like your new tearsheet format. Why not make all the pages this way?

Robert E. Feathers
Martinsville, West Va.

Praises Handbook

To the Editor:

I have nothing but compliments to offer to you for the presentation as well as the subject matter contained in your Process Handbook (September, 1958 issue). Perhaps the best way I can illustrate this feeling is to let you know that I have just renewed a three-year subscription to PETROLEUM REFINER.

Frank B. Odasz
Manager of Development &
Control, Husky Hi-Power,
Incorporated
Cody, Wyoming

See Page 87 for more letters.

For more data on advertised products, use Readers' Service Cards, last page.

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Our experienced technical staff will assist you in developing the best and most economical catalyst. If you have a catalytic process in the development or production stage, a discussion with us may prove beneficial.

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Pin your motor oil improvements on the Amoco Additive line

Detergents
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Detergents. Amoco barium and potassium salt detergents have exceptional properties. When blended with your oils, they effectively neutralize acids and hold products of combustion and other contaminants in suspension in high- or low-temperature service.

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Detergent-Inhibitors. Specially tailored blends to provide all of the performance characteristics desired in your finished motor oils.

The complex science of motor oil blending requires that men who market additives be experienced in this work. The men who sell Amoco Additives are engineers who have both laboratory and field service experience. Inquiries about Amoco Additives get their immediate attention.

AMOCO
CHEMICALS

AMOCO CHEMICALS CORPORATION
910 South Michigan Ave., Chicago 80, Illinois

The Mail Box . . .

Reference, Training

To the Editor:

Your Process Handbook (September, 1958) is very useful to me in several ways. I bind it and keep it handy for ready reference. The simplified flow sheets are used in training pilot plant technicians, while the condensed discussions give these technicians a better background in commercial processes. In this way they often stimulate our technicians to take greater interest in this work. The flowsheets also find their way into training programs which include personnel from other operating divisions of our company.

W. J. Alford
The Pure Oil Company
Crystal Lake, Ill.

Ivory Tower Sight

To The Editor:

The BEST editorial published this year in any technical journal is "The Case of an Engineer 'Shortage'" (PETROLEUM REFINER, June 1958, Page 121). Congratulations to PETROLEUM REFINER and Drs. William Cunningham and John McKetta for such an article. Sometimes, professors are depicted as living in ivory towers. If so in this case the tower at the University of Texas must be tall enough to extend beyond the cloud of propaganda exuded by the industry's ivory hunters.

The "case" described in their article reminds me of the historical custom in medieval times of throwing men into debtors' prison until they pay their bills. When profits are lagging and costs must be cut, the engineer is the one who will save the day, not the executive who issues an order, "cut personnel by 10 percent."

Carol E. Belton,
Big Spring, Texas.

Fixing Those Pages

To the Editor:

Concerning your article on "How to Fix Those Perforated Pages" in your September issue: If you remove the magazine's binding staples and loosen all the pages, you would get a wider margin suitable for binding. This method is better than those proposed.

Corona, Queens, New York
Thomas J. Hynes

Editor's note: if it works, you have got a better method.

IN DRYING GASES...

THE BEST DESICCANT YIELDS LOWEST COSTS

A drying installation is an important capital investment. Desiccant cost is a minor part of the total, yet *DESICCANT PERFORMANCE* is the measure of successful operation. Why risk your investment by use of an ordinary desiccant?

Molecular Sieves are the best desiccants. Five years of field service have proved these premium features—

- higher capacity
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You can afford to *specify* Molecular Sieves. Investment may be lower, because higher capacity often permits use of smaller equipment for the job. Before placing your next order, ask your vendor to quote on a Molecular Sieve dryer.

For more information on Molecular Sieves, ask for Technical Bulletin F-1026. Write to Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, New York.

"Linde" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

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Q&A

How serious is copper contamination in modern gasolines?

Du Pont's H. J. Scheule answers questions oil men have asked about the problems of copper contamination

Q. How serious is copper contamination in modern gasolines?

A. Copper is a powerful pro-oxidant. At concentrations as low as one part in ten million parts of gasoline it is capable of causing gasoline gumming.

Q. Why is it such a powerful pro-oxidant?

A. It acts as a catalyst, cleaving the relatively stable hydroperoxides in the gasoline to form chain-initiating free radicals.

Q. Are copper contamination problems associated only with gasolines which have been copper sweetened?

A. No. Du Pont surveys of service station gasolines indicate that over 90% of them contain catalytic quantities of copper.

Q. Where do gasolines pick up copper?

A. There are many sources both in the refinery and in the gasoline distribution systems. Any equipment containing copper or copper-bearing alloys, such as valves, heat exchangers, pumps and meters, is a potential source of trouble. Finally the automobile fuel system itself usually contains sources of copper.

Q. What can be done to combat the harmful effects of copper?

A. With few exceptions the addition of Du Pont Metal Deactivator (DMD) to the gasoline completely nullifies the effects of copper.

Q. How does it control copper-catalyzed gum formation?

A. DMD combines with dissolved copper to form a stable chelate. The additive literally surrounds the copper, rendering it inactive as a catalyst.

Q. Should a refiner depend upon the use of DMD alone to control copper contamination from copper sweetening units?

A. No. DMD should always be used in conjunction with these processes, but should not replace process steps designed to remove gross amounts of copper.

Q. At what stage in refinery processing should DMD be added?

A. It should be added as soon as possible but never before processing which embodies contact of the gasoline with acid or caustic solutions.

Q. Is DMD water soluble?

A. No. It is not extracted from gasolines by water solutions in the pH range of 4 to 8. Losses of the additive to storage tank water bottoms are seldom experienced.

Q. Does DMD disappear from finished gasolines?

A. Analytical methods normally measure uncombined DMD; therefore, they indicate a reduction in additive content as it combines with copper to form the chelate. Since the copper chelate is water soluble, it also is possible that both copper and the corresponding quantity of DMD disappear as a result of water extraction.

FOR MORE INFORMATION on the vital problem of copper contamination and gum prevention, call in your Du Pont Petroleum Chemicals representative or write to Petroleum Chemicals Division, E. I. du Pont de Nemours & Co. (Inc.), Wilmington 98, Delaware.

H. J. SCHEULE supervises technical service on gasoline additives at the Du Pont Petroleum Laboratory. His many years of experience include fundamental research on gasoline stability, working with refiners on gasoline treating problems and participation in cooperative technical groups on gasoline studies.

DU PONT

Better Things for Better Living
. . . through Chemistry

Tetraethyl Lead
and other
Petroleum Additives

For Business, More than Soft Talk

ARE THERE ANY among us who think the recent election to Congress of a large number of "liberals" and the defeat of Right-to-Work laws in a half dozen states was just a happenstance? If so, they should halt for intensive study of the definite program of political action that Big Unionism has under way. Facets of the program put down in relation to recent political results are enough, we hope, to jar a lot of people into action.

Forgetting for a moment the threat of Communism so rampant in such large areas of our sphere right now, it can be said that here in the U. S. A. there is a raging war, a war to influence the minds of men. And how is the American way of doing business, how is management—those who believe in the merits of our system of free enterprise, faring in this war?

We can cite right quick how Big Unionism is doing. They are going all out, are using all media to propagandize and thus mold public opinion. Their use of the printed word is so much more effective than business's that there is no comparison. Union papers generally have struck at Republican leaders at every opportunity and manufactured the opportunity where one is needed. "Senator Knowland engineered a drive on labor and was joined in by the White House"—in this manner they reported the Californian's move for a broader and more general debate on the bill for worker welfare. According to Big Union thinking, Knowland was attempting to "cast a pall over the prospects for the sweeping but clearcut welfare bill."

In another Big Union paper a pre-election editorial contended "Republicans have made organized labor their whipping boy in the campaign in a way that hasn't been seen in many years."

Big Union Slant. Other articles—virtually all of them "slanted"—deal with costs of living, right to work laws, corporate profits, political campaigns in individual states, and the economy of the nation—just to mention a few.

One cartoon showed the Democrat donkey pushing a reluctant President Eisenhower down the road entitled "Federal Government Anti-Recession Measures." The president was in a turtleshell and was holding a sign which read "Wait—not so fast."

That same issue of the *OCAW Union News* contained a pullout section listing all congressmen and how each voted on 10 important bills. Shown was not "for" or "against" as you would normally expect, but "R" or a "W"—meaning whether each man had voted "right" or "wrong" according, of course, to the Big Union viewpoint.

Employe publications are about the only means whereby companies reach the same persons as do the Big Union papers; so let's look at a recent survey of 65 of the 75 such periodicals reaching nearly a million employes in the St. Louis area. For the most part their contents dealt with safety, good housekeeping, self-improvement and anniversaries, along with a lot of chit-chat of employe social activities. Almost totally neglected were such subjects as corporate profits, handling of grievances, the employe's stake in the company and particularly, management's views on "controversial" issues affecting labor and industry.

A similar survey in Chicago revealed the same thing. Of 150 internal publications, only 12 contained information about management's views on important industrial issues.

Opportunities Muffed. Koppers Co., Inc. recently made a study of the Big Union and the top 35 industrial publications to see how, over the same period, they treated such issues as the price-wage spiral, Right-to-Work laws, corporate profits, revision of the Taft-Hartley act and extension of the minimum wage act. In the Big Union publications 15 percent of the space was used in giving rank and file members the viewpoint and policy of the union leaders. On these five subjects alone 103 articles were printed in just seven of the Union papers. Too, the text was not necessarily written in true editorial style such as you read in most daily newspapers, but rather the editor very ably "slanted" most of the accounts to grind the Big Union ax.

Conversely, the 35 company employe publications presented little or nothing on the same topics. Two of the periodicals contained one article each, another presented management's view in three articles.

Boiled down, our U. S. companies seem to be ducking the fight while Big Unionism continuously is pounding away—frequently with brass knucks.

In Schools, Too. Big Unionism, too, has taken a cue from certain dictator countries and is employing tactics that seek to mold the minds of school children

Planning ahead can save $20,000 on fluid mixing

An idea from your LIGHTNIN MIXER representative's briefcase

This engineer is listening to an idea that's going to save his company $20,000 on fluid mixing.

He's working on a process that will employ mechanical mixers. But in a year or so, process requirements are expected to change, throwing 15% greater load on the mixers.

Problem: how can the engineer anticipate the change now so as to avoid heavy replacement costs later on?

Solution proposed by the LIGHTNIN Mixer representative: install standard turbine-type LIGHTNIN Mixers geared for the immediate job, but sized to handle the expected load.

When requirements increase, simply change impellers and two gears in each mixer—providing correct power input for the new conditions at minimum expense.

This is one example of many ways your LIGHTNIN representative can help you get efficient fluid mixing at lowest long-term cost.

What this man can do for you

He can give you better service on fluid mixing than anyone else—because he has seen and done more of it.

He helps you stay ahead of competition, by bringing you the newest mixing developments first.

He gives you the assurance of being *right,* because his recommendations stem from years of field work, plus realistic pilot-run data developed at MIXCO. We back him up by guaranteeing results, unconditionally.

Take advantage of his unmatched experience by putting him on your process-design team. For prompt help on any fluid mixing operation, call him in now. You will find him listed in Refinery Catalog. Or write us direct.

Lightnin® Mixers

MIXCO fluid mixing specialists

MIXING EQUIPMENT Co., Inc., 164-n Mt. Read Blvd., Rochester 3, N.Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 19, Ont.

while yet they are in the most formative stage. Each year in Texas, for example, the AFL-CIO offers a sum in scholarships for winners of essays. Want to guess the topics which must be discussed: "You Should Join a Union," "Why Union Should Take Part in Politics," "The Case Against Right To Work Laws," "What Organized Labor Means to My Family," and "Union Wages and the Nation's Prosperity."

By this maneuver Big Unionism was spending less than one cent per student to reach a large number and to get active interest and participation from many of the 400,000 high school students in Texas.

Along these same lines, a recent *Wall Street Journal* headline read, "AFL-CIO Goes Madison Avenue, Mulls How to Spend $1.2 Million to Sell Unionism." The story dealt with how the AFL-CIO committee would spend its new public relations budget which is nearly double last year's. Among the suggestions reported were to distribute copies of the *AFL-CIO News* to every high school and college library in the country. Another suggestion was to flood the nation's school with union pamphlets.

If either of these programs are carried out, no doubt they will expound only the Big Union philosophy and the Big Union brand of economics.

Here is one more illustration of the many, many angles which unions play in order to get their points across to your employes: A new song book titled "Songs of Work and Freedom" has just been authored by two "education" directors of the Rubber Workers and it is expected that soon the Labor Education Division of a mid-western university will publish the book. More than 100 songs, complete with words and music, plus notes in the background of the individual songs will be included. "Picket line songs, songs of the coal mine and the textile mill, railroad and steel songs, depression songs, spiritual songs of freedom and protest—all of them are here," says the prospectus.

Time to Fight. It's high time that management stops walking softly and starts rolling up its sleeves because the pendulum is swinging further toward Big Unionism views each succeeding day. Example: How the Right-to-Work elections came out last month. This law, which says that a man does not have to join a union in order to earn a living, was quite heavily rejected in Ohio, California, Colorado and Washington; defeated by a slim margin in Idaho and passed only in predominantly rural Kansas.

On this one particular issue Big Union leaders managed to convince millions of people, both unionists and non-members, that this was a "union busting" proposal. It also proved, as if any more proof was needed, that Big Unionism is a political and influential power of the first magnitude.

Some large corporations in recent months have served notice of an intention to speak and act more forcefully in political matters. And that is well and good. But here again they might take a leaf from Big Unionism's book and go about it systematically and on a nationwide scale. No haphazard, now-and-then jabbing is going to do the job. We have a system that has made America great; so why should those who believe in it hesitate about getting together so that individual groups and the nation at large can be told and sold?

In this struggle the winner takes all—and from many indications the stakes are just that, the American system of free enterprise. It's clearly up to management to organize and carefully plan to halt this encroachment. And, if management isn't alert enough, or doesn't care to accept this responsibility —then, may it be asked, who will?

Kobe Record A Brilliant One

THE CONTRIBUTION which Kenneth A. Kobe has made to science in general and petroleum processing in particular is a considerable one. Besides the training of young chemical engineers, which perhaps was his forte, his continuous study and research, which he carried on with truly dedicated zeal, made him one who was widely sought as an industry consultant. And in this role, too, he rendered invaluable service.

Dr. Kobe

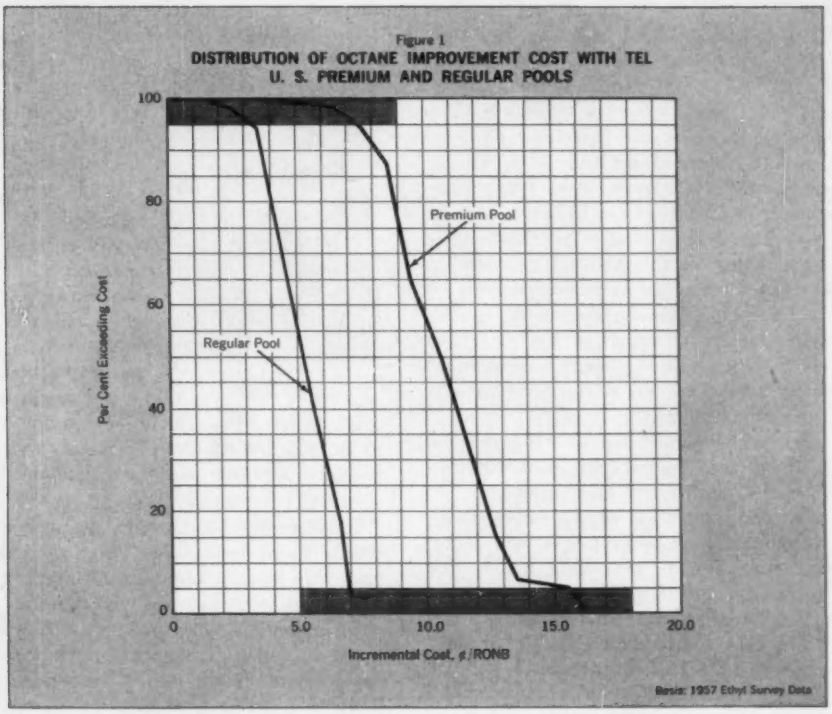
Another task which he did so well—the one that appeals to those of us in the field of communications—was his willingness at all times to publish his scientific findings. Besides authoring five books, he published some 200 scientific articles, 34 of which, incidentally, were presented in PETROLEUM REFINER. Certainly the sharing of this material in itself was a tremendous service to the world of science.

As a member of chemical engineering faculties in several large universities, Dr. Kobe helped to mould and train literally hundreds of minds. He was known as a tough prof, but one who prepared every lecture with meticulous care and one who was ever willing to dig in and come up with answers to any questions his students might raise. Saturdays, Sundays and holidays found him at his desk concentrating on his study and research which was something of a passion with him.

All of these things combined made him what he was—a great scientific contributor to a developing industry. He was known best for his work on submerged combustion, thermodynamic properties of petrochemicals and nitration of aromatics and it is in these fields that the "Kobe" reference will appear for decades to come.

Dr. Kenneth A. Kobe, brilliant teacher, researcher and scientific author died on November 2 at the age of 53 years in Austin, where he had served as a chemical engineering professor at the University of Texas for the past 14 years.

New data on economics of octane improvement



Ethyl Research appraises the use of tetraethyllead in refinery gasolines; summarizes recent data

by **C. J. WOLF**—*Refinery Technology Division*

RESULTS of Ethyl's study of the economics of tetraethyllead in current refinery gasolines now are available to oil companies as a means of comparing octane improvement costs.

This annual statistical review by Ethyl Research Laboratories in Detroit also includes an historical picture of Fall refinery fuels for the past several years.

Data are presented nationally and for the Eastern, Midwestern, Southwestern, Rocky Mountain and Western regions.

1957 Sample Data Represent 80% of U. S. Crude Capacity

For this study, Ethyl's Fall survey of refinery gasolines was supplemented by data on additional fuel samples received by our Gasoline Testing Division from many independent refineries. Approximately 170 samples each of premium and regular fuels were processed, representing almost 80 percent of the crude running capacity in the United States.

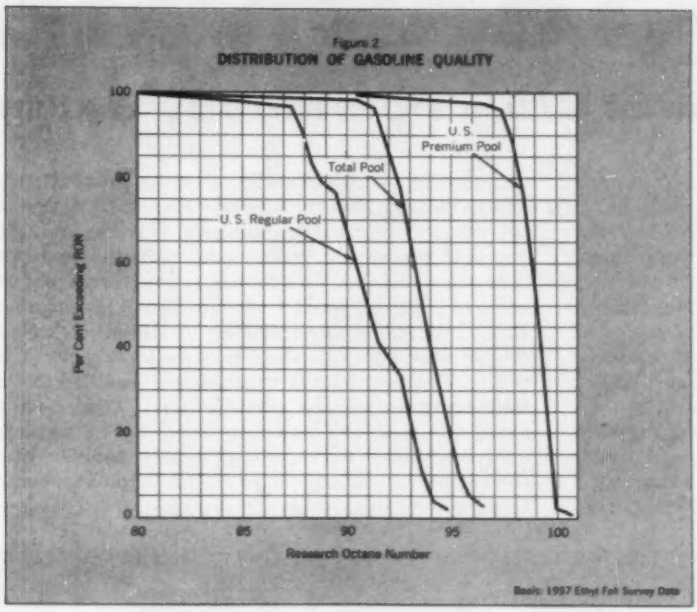
Each sample was weighted to reflect the crude running capacity of the refiner. Here are the weighted characteristics of the premium and regular gasolines and the combined pool in the United States.

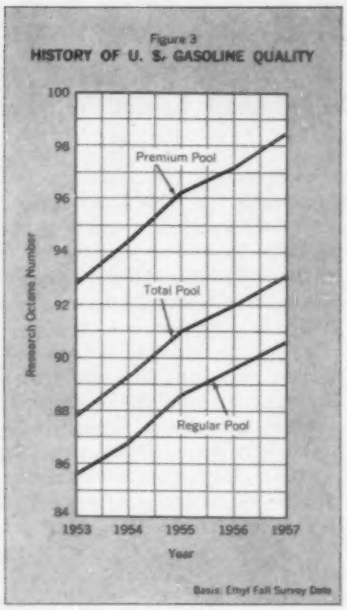
	RON	TEL Conc. ml/gal.	¢/RONB as received	RON Gain due to 3.0 ml TEL
Premium	98.4	2.58	10.10	0.4
Regular	90.6	2.18	4.79	1.4
Pool	93.2	2.31	6.50	1.1

Octane Improvement Cost Calculations

The cost of octane improvement using tetraethyllead was determined in units of cents per Research octane

For more data on advertised products, use Readers' Service Cards, last page.





number barrel (¢/RONB). The following equation was used:

$$¢/RONB = \frac{42C\,(T+0.5)\,PN}{2800M}$$

Where

C=TEL cost, cents per milliliter
T=TEL concentration, ml/gal.
PN=performance number
M=TEL susceptibility

Tetraethyllead susceptibility data were developed for each sample from the antiknock quality on an "as received" basis and plus 2.0 ml TEL per gallon.

TEL Costs 3.5 to 15.0 ¢/RONB

Octane improvement costs using tetraethyllead are shown by the distribution curves in Figure 1. If the terminal five percent portions of the curves (shown as shaded) are not considered, the range of incremental costs is from 7.5 to 15.0 ¢/RONB for premium gasolines and 3.5 to 7.0¢/RONB for regular gasolines.

Current data indicate the costs of octane improvement by processes such as isomerization and aromatic extraction, or by increasing reformer severity, range from 12.0 to 20.0 ¢/RONB. It would follow then that these processes are economically justified for the production of premium gasolines but not for regular gasolines.

Trends in Gasoline Quality

Data from the years 1953 to 1957 show the significant increase in the antiknock quality of U.S. gasolines since 1953, but a lower rate of increase since 1955.

Other comparative data give the year by year trends on tetraethyllead concentration, possible gain in Research octane number due to 3.0 ml of tetraethyllead per gallon, tetraethyllead susceptibility, octane improvement costs, and sensitivity.

How Ethyl Research is helping you

Since 1953 Ethyl Research has made an annual appraisal of the economic status of tetraethyllead as a means of octane improvement. Data from these studies have been used as a statistical reference on refinery gasolines for both current and historical review.

Widespread interest has prompted Ethyl Corporation to summarize these data (1953-57) for the Petroleum Industry in report form.

Copies of the report, entitled "Economics of Tetraethyllead in Refinery Gasolines," are available from your Ethyl Representative or by writing Ethyl Corporation, 100 Park Avenue, New York 17, N. Y.

Further, if you would like to discuss octane improvement costs with one of our Refinery Technologists, your Ethyl Representative will be glad to arrange a meeting.

ETHYL CORPORATION
NEW YORK 17, N. Y.

ETHYL
ANTIKNOCK COMPOUND
ETHYL CORPORATION

RESEARCH LABORATORIES:
1600 W. Eight Mile Road, Ferndale 20, Mich.
2600 Cajon Road, San Bernardino, Calif.

For more data on advertised products, use Readers' Service Cards, last page.

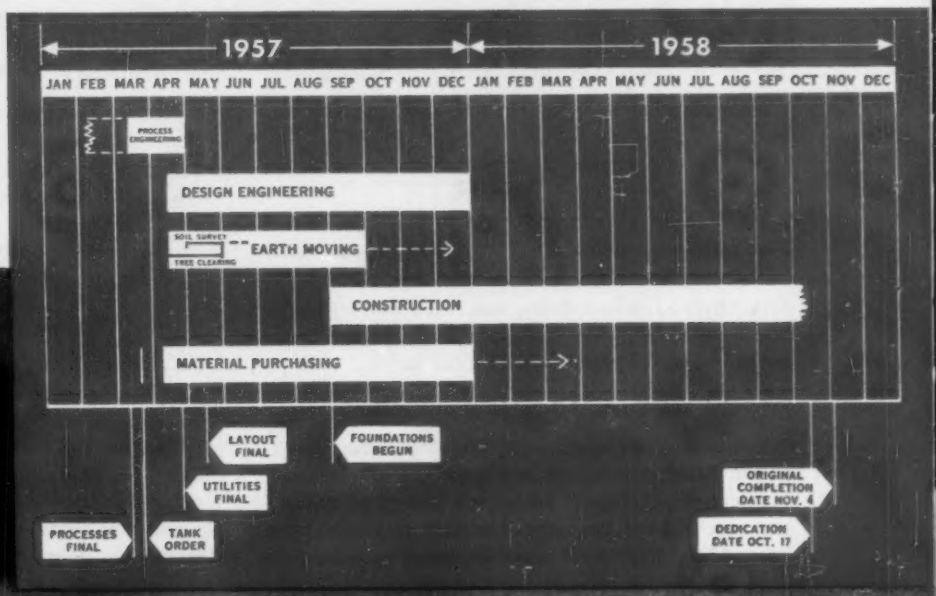
Unique Teamwork

Speeds Completion of B/A's Port Moody Refinery

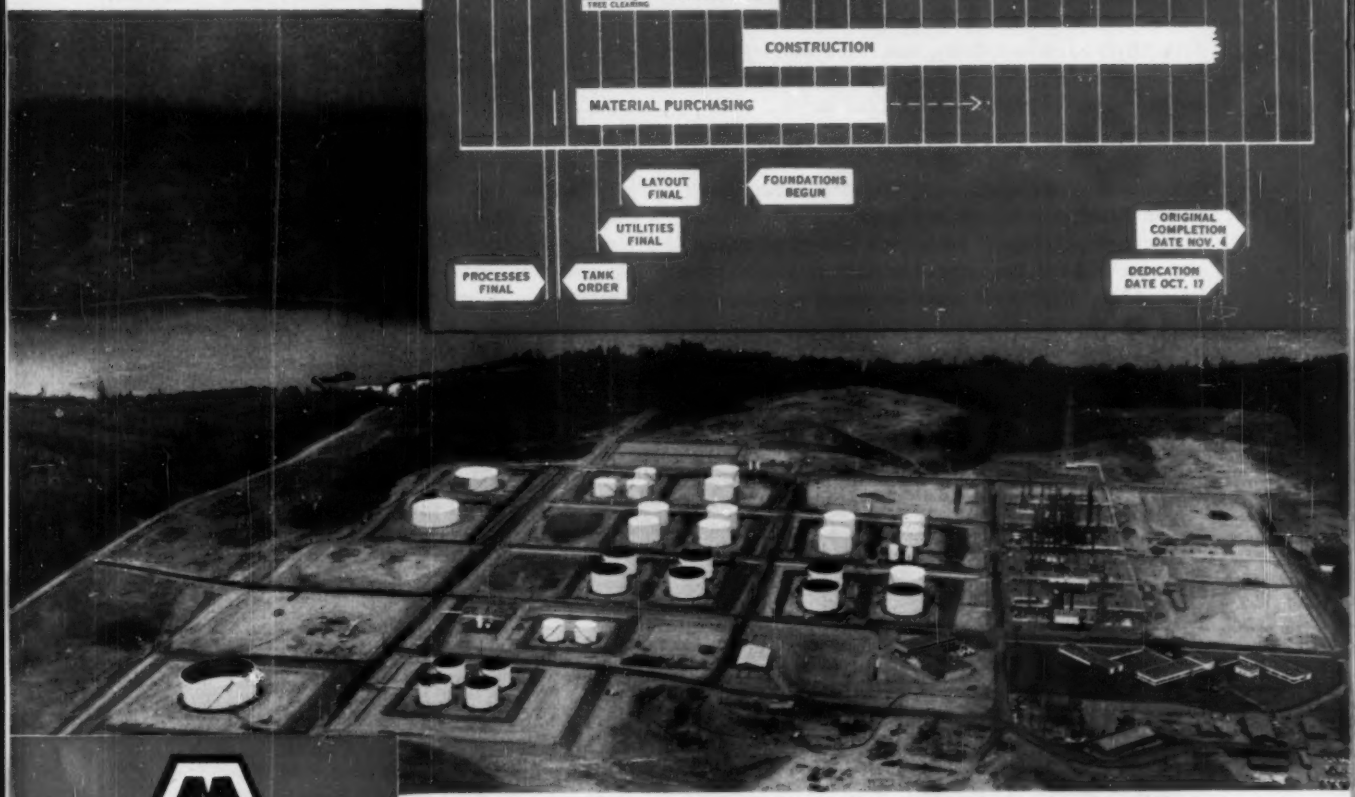
Foreseeing unusually rapid changes in the West Coast marketing situation, the British American Oil Company in the Spring of 1957 decided a new "grass roots" refinery was required in the Vancouver area by the Winter of 1958. Eighteen months or so is a short time to plan and execute a refinery project. Canadian Kellogg's accomplishment of this unusual speed record is a testimony to the B/A organization and its ability to delegate decision-making. Working with a special team of B/A engineers who could make decisions "on the site", Kellogg completed the project ahead of schedule.

One of the first things Canadian Kellogg required were horses—the only transportation the engineers could use to negotiate the muddy conditions on the site. But a strategically placed drainage and pumping system soon dried the ground and proved so effective that after its installation not one day's labor was lost through wet conditions. Other practical solutions to construction problems, plus the most advanced chemical engineering, have made the investment per barrel capacity of the B/A Port Moody refinery relatively very low.

Right from the start Canadian Kellogg's experience and B/A's cooperation pushed the job ahead of schedule. Of course, B/A and Canadian Kellogg have worked together before. The Port Moody contract was awarded to Canadian Kellogg mainly on past performance . . . this move in itself saved the time and money normally spent preparing and analyzing detail bids. Mutual respect between client and contractor was one of the outstanding factors that contributed to the speedy completion of the project.



Right: *Chart shows rapid construction progress made on the Port Moody project.* Below: *Air view of new B/A Port Moody refinery, Vancouver, British Columbia. Process section, right, is subdivided into five areas: (1) Crude Unit, (2) Catalytic Reformer and Distillate Desulfurization Unit, (3) Utility Plant, (4) Orthoflow® Fluid Cat Cracker, and (5) Alkylation Unit.*



KELLOGG

THE M. W. KELLOGG COMPANY, 711 THIRD AVENUE, NEW YORK 17, N. Y.

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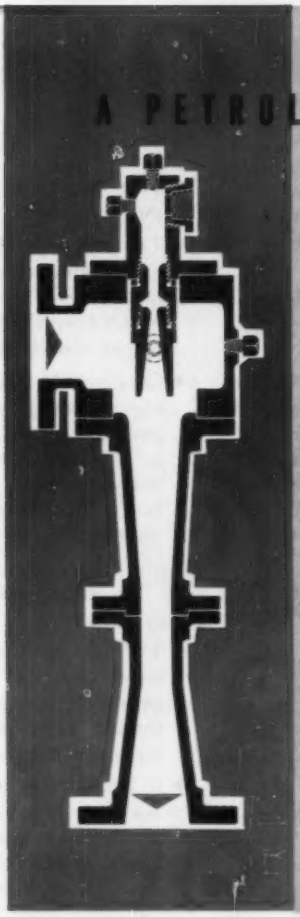
A PETROLEUM REFINER SPECIAL REPORT

EJECTORS



EJECTORS ARE SIMPLE pieces of equipment. Nevertheless, many of their possible services are overlooked. They often are used to pump gases and vapors from a system to create a vacuum. However, they can be used for a great number of other pumping situations.

Here are three articles which will help you answer questions about this type of equipment. The first, "Ejectors Have Wide Range of Uses," suggests ways to harness this equipment to an advantage. It gives a check list of information needed by the vendor.

If you can then use the typical steam jet ejector, the second article tells points to consider when you "Figure What an Ejector will Cost." The third article, suggesting "How To Get The Most From Ejectors," gives tips on trouble-shooting and choosing materials of construction.

Harold L. Hoffman
PROCESS AND CONSTRUCTION EDITOR

Ejectors Have a Wide Range of Uses

This introduction to ejectors will show you some of their many uses, and the handy check list will help you get the right one for the job

F. Duncan Berkeley
Graham Manufacturing Company, Inc., Batavia, N. Y.

EJECTORS ARE employed in the industry in numerous, unique and even sometimes bizarre ways. They can be used singly or in stages to create a wide range of vacuum conditions, or they can be operated as transfer and mixing pumps. The ejectors have the following advantages over other kinds of pumps:

- Rugged and simple construction
- Capability of handling enormous volumes of gases in relatively small sizes of equipment
- Less maintenance requirements
- Simple operation

WHAT MAKES THEM WORK

All ejectors operate on a common principle. The single stage ejector, in its simplest form, consists of an actuating nozzle, suction chamber and a diffuser. The actuating fluid, which may be a gas, vapor or liquid, is expanded from its initial pressure to a pressure equal to that of the secondary fluid. In the process of being expanded, the actuating fluid is accelerated from its initial entrance velocity, which is negligibly small, to a high velocity. In the suction chamber, the actuating fluid induces a region of low pressure-high velocity flow which causes the secondary fluid to become entrained and mixed with the actuating fluid. During the mixing process, the actuating fluid is retarded and the secondary fluid is accelerated. As the mixture enters the diffuser, it is compressed to the exit pressure by rapid

deceleration. The purpose of the ejector is to transport and compress a weight of induced fluid from the suction pressure to the exit pressure. By staging ejectors it is possible to obtain a very large range of suction pressures from atmospheric down to as low as one micron of mercury absolute.

In multistage ejectors, it is usually advantageous to condense the steam from each stage in a water-cooled intercondenser so as to reduce the load to the succeeding stage. This reduces the size and steam consumption of the succeeding stages and results in a much more efficient ejector system. Of course, the steam condensing must take place at a pressure above that corresponding to the saturation pressure of the cooling water.

An intercondenser, however, increases the initial cost of an ejector. It must be determined, therefore, whether or not the additional expense of an intercondenser is worth the savings that will be forthcoming in steam economy. Small ejectors for pilot plants, laboratory use or intermittant service may not warrant intercondensing. As many as 4 or 5 non-condensing stages may be justified under some circumstances.

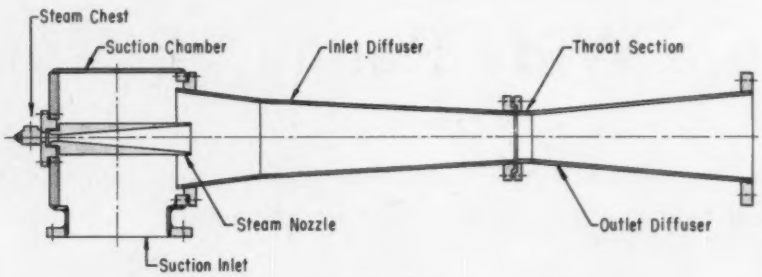
Wherever it is desired to reclaim condensate, it is good practice to use a condenser on the final stage of an ejector system which discharges to atmospheric pressure. An aftercondenser, as it is commonly called, will serve to silence any noise that may issue from the discharge of the final stage. An aftercondenser also eliminates the nuisance or objection of discharging steam in a confined area. Aftercondensing does not increase the efficiency of an ejector, but it may increase the efficiency of the steam generating cycle by reclaiming condensate or preheating boiler feed water.

Condensers for ejectors are available in either surface type or direct contact type (barometric or jet condensers). Direct contact condensers have the following advantages.

- They cost less than a surface type designed for equal service.
- They seldom or may never require cleaning.
- The problems with corrosion are usually minimized in a direct contact condenser since the corrosive media from the ejector is diluted by the condensing water.
- Condensable vapors of relatively high vapor pressure which are partially soluble in water, such as ammonia, can be more effectively condensed in direct contact condensers because of the diluting effect of the cooling water.

Surface condensers, on the other hand, are advantageous for the following reasons:

- They do not mix the cooling water with the condensate thus permitting recovery of the condensate which may be suitable for boiler feed water.
- If height limitations require the use of a condensate pump only a relatively small pump is required as compared to a low level direct contact condenser where the pump must handle both the condensate and the cooling water.
- If the condensate contains a corrosive, poisonous or radioactive substance, special provisions may be necessary for disposing of the condensate which can be kept to a minimum by the use of a surface type condenser.



THESE PARTS MAKE AN EJECTOR

STEAM CHEST. This is the connection through which the high pressure motive steam supply is introduced.

SUCTION CHAMBER. This provides a plenum chamber with the appropriate connections for the suction inlet, diffuser and steam nozzle. This part can sometimes be eliminated by incorporating the diffuser connection and steam nozzle connection in the vessel which is to be evacuated. Frequently more compact designs and savings in cost can result from such designs.

STEAM NOZZLE. This is the heart of an ejector since it converts the energy of pressure to velocity and directs the flow of motive steam into the diffuser.

INLET DIFFUSER. This provides a correctly shaped introductory section and converging diffuser section to handle the high velocity flow of fluids. It is in this section that entrainment and mixing of the motive and load fluids is completed and the energy of supersonic velocity is converted to pressure.

THROAT SECTION. This is the transition piece between the converging supersonic inlet diffuser and the diverging subsonic outlet diffuser.

OUTLET DIFFUSER. This provides a correctly shaped diverging diffuser section for completing the conversion of velocity to pressure. After the fluid flow has passed through the throat of the diffuser, the flow is essentially subsonic. The outlet diffuser section further reduces the fluid velocity to a reasonable level so as to convert practically all the velocity energy to pressure energy.

HOW THEY OPERATE

Most ejectors have a fixed capacity curve as shown in Figure 1. In this type of ejector the capacity is a function of the absolute pressure at the suction inlet. Increasing the steam pressure above the design pressure will not increase the capacity of the ejector; as a matter of fact, it will actually decrease the capacity because of the choking effect of the excess steam in the diffuser throat.

In contrast to the fixed capacity curve of Figure 1, some ejectors have a family of capacity curves, as shown in Figure 2, where the capacity is also a function of the steam pressure. These designs are referred to as *throttling type* ejectors because the capacity can be decreased by decreasing the steam pressure. In these designs, the ratio of discharge pressure to suction

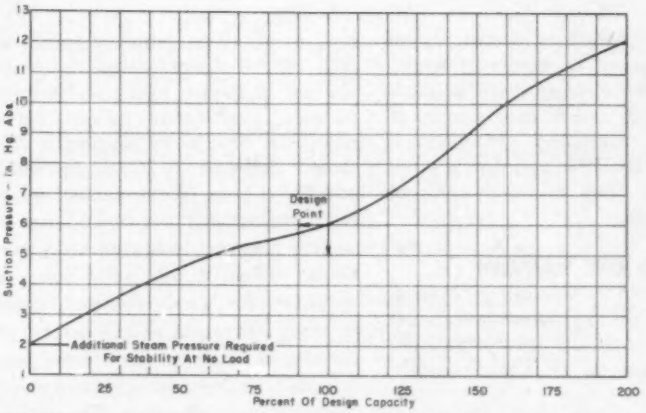

Suction Pressure - In. Hg Abs.
Design Point
Additional Steam Pressure Required For Stability At No Load
Percent Of Design Capacity

FIGURE 1—For a fixed-capacity ejector, increasing the steam pressure will not increase the capacity.

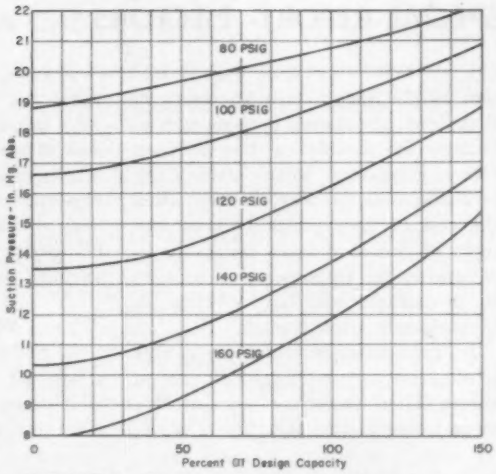


FIGURE 2—The capacity of a throttling ejector is a function of both the suction pressure and the motive steam pressure. Basic design here is 100 psig.

pressure is relatively low as compared to fixed capacity designs.

Ejectors are most sensitive to changes in discharge pressure. If the discharge pressure on an ejector exceeds its maximum stable discharge pressure, the operation will become unstable and the capacity will no longer be a function of the absolute pressure. Stabile operation can be attained either by increasing the steam flow or by decreasing the discharge pressure.

For stable operation, the steam pressure for most ejectors must be above a certain level. This lower boundary will have two magnitudes depending upon whether the steam pressure is approaching the transition point from the unstable side or from the stable side.

If the steam pressure is being increased from a region of unstable operation, the point at which the ejector first becomes stable is called the *motive steam pickup pressure.* The pickup pressure is a direct function of the discharge pressure. At the higher discharge pressure, the ejector will regain its stability once the motive steam pressure is increased to the pickup pressure; but the absolute pressure for a particular load may be increased slightly from what it was at the lower discharge pressure.

For every discharge pressure in an ejector there is also a minimum steam flow below which the operation will be unstable.

If the steam pressure is being decreased from a region of stabile operation, the point at which the ejector becomes unstabile is called its *motive steam break pressure.* The motive steam break pressure is below the motive steam pickup pressure for any given discharge pressure and load. For this reason, the ejector operating with steam pressure between the break and pickup points may be stable or unstable depending on the direction of the steam pressure change.

The terms "break" and "pickup" pressures are also used in reference to the discharge pressure of an ejector for the pressures at which ejector operation becomes unstable and stable, respectively. These critical discharge pressures are a function of the steam pressure and load.

Some ejector stages have no motive steam break and pickup pressures because of the low ratio of discharge pressure to suction pressure over which they operate, or because they are designed to eliminate this characteristic. In these ejectors the capacity varies directly with steam pressure over certain operating limits.

Single-Point Design. If only one load and vacuum are required for a particular application, single and multistage ejectors can be designed specifically for one condition. This saves steam.

Occasionally, however, single-point design ejectors are not always stable at very light loads or at loads slightly in excess of design. An ejector of this design is not necessarily undesirable if the ejector always operates at the exact design conditions. This, of course, depends on whether or not it's possible to determine accurately the load on the ejector before hand.

Close designs can often result in substantial steam and water savings in large systems. However, it is usually not possible to determine exact operating conditions prior to design. For this reason single-point designs are not in general use.

Multipoint Design. Occasionally an ejector must operate alternately at two or more conditions of load and vacuum. In this instance the ejector must be designed for the most difficult conditions (or the conditions that call for the largest ejector). The other conditions will then fall within the performance curve of the larger ejector.

An ejector of this type is sometimes considerably oversized for some of the required conditions in order to achieve the most economical design from the standpoint of initial cost. If operational economy is important at each of the conditions, it may be desirable to use two separate ejectors to achieve efficiency at both operating points.

It is possible in some applications to provide an ejector for two or more different operating conditions—with maximum efficiency at each point—by providing a steam nozzle or diffuser designed for each condition. In changing operations from one condi-

tion to the other, it is necessary to shut down the system long enough to change the nozzle or the diffuser. Often, substantial steam savings can be realized in this way, thus avoiding the cost of two ejector systems. Designs of this kind have found applications in the recompression boosters for evaporators and large ejectors for high-altitude wind tunnels.

In certain applications an ejector is required to meet a specific design curve. Then sometimes considerably more steam is used than for a single-point design to produce the desired characteristic curve. At some point in the curve the ejector is, of course, relatively efficient and at either side of this high-efficiency point the ejector is relatively inefficient.

Stages Give Versatility. It is possible to meet a large variety of operating conditions economically with multistage ejectors by operating only some of the stages at a time.

All ejectors have at least as many different performance curves as they have stages. For a particular stage to operate, all the succeeding stages must, of course, be operating. Practically all points within the envelope formed by these curves can be reached by the ejector. Thus, the ejector can cover an entire area of possible operating conditions.

Six and seven stages of compression have lengthened the range of operation of steam ejectors down to absolute pressures as low as 1 micron of Hg (0.001 mm. Hg). Commercial designs are available and should often be used in place of other kinds of vacuum pumps.

TO GET VACUUM

In the field of vacuum processing, steam jet ejectors have been most widely used. Steam jet ejectors are ideal for use on all kinds of stills, vacuum deaerators, evaporators, crystallizers, oil deodorizers, steam vacuum refrigeration, flash coolers, condensers, vacuum pan dryers, dehydrators, vacuum impregnators, freeze dryers, vacuum filters and more recently on stream degassing of metals and vacuum melting of metals. Steam jet ejectors offer operational and economical advantages over a very large range of pumping capacities. Corrosive applications are easily handled providing a suitable material is available that can withstand the corrosive medium in question with reasonable structural strength at the temperatures to be encountered by the ejector system.

Figure 3 is a comparison of capacity and operating range for most of the common designs of steam jet ejectors handling any non-condensable gas such as air. This graph is based on each of the designs using the same amount of motive steam at 100 psig pressure. Each point on the curve represents a point of maximum efficiency, therefore, it should be borne in mind that an ejector cannot necessarily operate over the entire range of suction pressures indicated for a particular design. A reasonable range of operation for good efficiency would be from 50 percent to 115 percent of the design capacity. An ejector may operate well in excess of these figures; however, the efficiency will usually decrease at points beyond these limits.

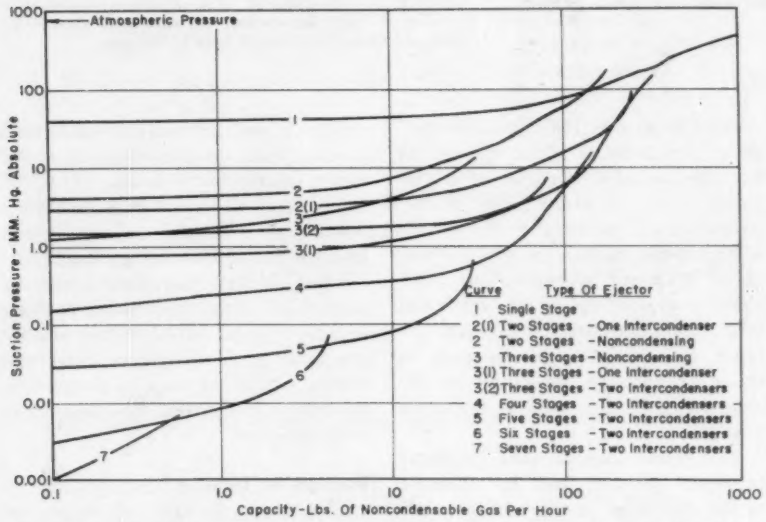


FIGURE 3—A wide range of pressures can be achieved by using various combinations of ejectors and condensers. The same steam consumption is used for each design here.

Water temperature affects the load which may be handled by an ejector. If condensing water colder than 85 F. were used for our comparison in Figure 3, all of the curves representing the performance of ejectors that require water would be shifted to the right, indicating an increase in capacity for these designs.

If water warmer than 85 F. were used, the shift in these curves would be to the left. And if the water temperature were high enough, some of the curves would move far enough to the left to disappear from the graph entirely.

The effect of water temperature is more critical on ejectors designed for low absolute pressures. For example; in a 4-stage ejector, the increase in capacity for 65 F. water over 85 F. water for a particular steam consumption will be greater at 1 mm. Hg. Abs. than at 4 mm.

Steam pressures higher than 100 psig will permit designing for a larger capacity for a particular steam consumption. A greater benefit from high steam pressures can be realized in 1- and 2-stage ejectors than in other designs.

The benefit from high-steam pressures becomes less as the absolute pressure for which the ejector is designed decreases. Single-stage ejectors designed for absolute pressures less than 200 mm. Hg. Abs. cannot operate efficiently on steam pressures below 25 psig. However, initial stages

USE THESE SPECIFICATION CHECK LISTS

STEAM JET EJECTOR

Application_____
Absolute pressure to be maintained by the ejector_____
Fluids to be handled by the ejector_____
Noncondensables gases, #/hr._____ M.W._____
Water vapor, #/hr._____
Condensable vapors other than water vapor:
#/hr._____ M.W._____
Temperature of load fluid, F._____
Steam pressure available at the ejector, psig_____
Steam temperature at the ejector, F._____
Cost of steam (if known), $/1,000 lbs._____
Is cooling water available for intercondensing?_____
Cooling water source? Cooling Tower ☐
City supply ☐ Well ☐
Cooling water temperature at the ejector, F._____
Cooling pressure at the ejector, psig_____
Cost of cooling water (if known), $/1,000 gal._____
Is cooling water relatively clean?_____
Turbidity (if known)_____
If evacuation time to establish the required absolute pressure in the system is important, then state net volume to be evacuated—cu. ft._____
Time allowed for evacuation, minutes_____
Will system to be evacuated be wet or dry?_____
If wet, state liquid present and quantity to be removed by evaporation.
Altitude at installation if abnormally high_____
Discharge pressure final stage_____
Type of intercondenser preferred?
Surface ☐ Direct Contact ☐
Is an aftercondenser required?
Type: Surface ☐ Direct Contact ☐
Is economy of operation to be stressed?_____
Is low initial cost of ejector to be stressed?_____
Any limitation on steam supply available that might affect ejector design?_____
Any limitation on water supply available that might affect ejector design?_____
Is installation to be inside or outside?_____
Is A.S.M.E. Code construction required on inter and aftercondensers?_____
Are there any other construction codes required?_____
Is there any special painting required?_____
Is there any special orientation of components to be considered?_____
Is there any space limitation to be considered?_____
Is there any weight limitation to be considered?_____
Size of suction connection from system to ejector_____
Is there any special supporting structure to be furnished?_____
Accessory equipment to be furnished with ejector:_____
Steam valves, strainers and interconnecting steam piping_____
Condensate pumps_____
Discharge head required_____
Electric power available: cycles_____
volts_____ phase_____
Electric motors to be: Drip proof ☐ Splash proof ☐
TEFC ☐ Explosion proof ☐
Steam purifier_____
Liquid level controls for intercondenser hotwell_____
Traps_____
Spare parts_____
Other equipment_____
Material: Diffuser and suction chamber:
Standard_____ Special_____
Steam nozzle: Standard_____ Special_____
Inter and after condenser-shell:
Standard_____ Special_____
(If shell & tube) Tubes: Adm._____ Special_____
(If shell & tube) Tube sheet: Steel_____ Special_____
Standard materials are chosen to resist ordinary corrosion of steam and water. If corrosive vapors or liquids are involved, state under special material customer has found best for his operation. Is export packing required?

WATER OR LIQUID JET EJECTOR

Suction Pressure to be maintained_____
Discharge Pressure_____
Total load fluid #/hr._____ Temp. F._____
Load Fluid: Liquid #/hr._____ M.W._____
Non-condensables #/hr._____ M.W._____
Condensable Vapor #/hr._____ M.W._____
Propelling Liquid_____
Propelling Liquid Pressure, psig_____
Propelling Liquid Temperature (Maximum), F._____
Properties of propelling liquid (if other than water)_____
Specific Gravity_____
Specific Heat, Btu/#—F._____
Vapor Pressure at inlet Temperature, psia._____
Materials of Construction
Suction Chamber_____ Diffuser_____
Steam Nozzle_____ Steam Chest_____
Accessories
Propelling liquid valve_____
Propelling liquid strainer_____
Other equipment (if any)_____

of multistage ejectors can often be designed to operate efficiently on steam pressures below 1 psig.

It is not uncommon to use an extra stage for an ejector designed to operate on steam pressures as low as 15 psig.

It is very important that the steam used to motivate ejectors be at least dry-saturated steam. Small amounts of moisture can be removed successfully by using a good, properly sized steam separator which will remove 98 to 99 percent of the moisture entering the separator.

Water jet ejectors are available that can economically handle a nominal amount of air leakage in vacuum equipment along with a large condensable vapor load. Water pressures as low as 10 to 20 psig will sustain a moderate vacuum while water pressures of 40 psig and higher will efficiently sustain a vacuum in the range of 4.0 inches to 1.0 inch Hg. Abs. pressure with a single stage ejector depending on the load to the ejector and the temperature of the motivating water.

The water operated ejector combined with a steam jet ejector can yield a very compact, efficient and relatively inexpensive vacuum pumping system. The water jet ejector serves both as an intercondenser and a final stage to the ejector system. In instances where the non-condensables entering the ejector system are small compared to the condensable vapors, say 10 percent by weight non-condensables or less, the water jet ejector can take the place of a two stage ejector in maintaining a suction pressure of 3 inches to 2 inches Hg. Abs. to which the steam jet ejector can discharge. The result is a low priced and efficient vacuum pumping system. In Europe, an interesting equivalent to the water ejector is a centrifugal water jet ejector which combines a centrifugal pump with the ejector principle and which recirculates the motive water handling air and vapor loads in a single piece of equipment. It is likely, however, that the combination of a separate centrifugal

pump and a separate water jet ejector would be a more competitive pumping system than the European centrifugal ejector pump.

STEAM VACUUM REFRIGERATION

In recent years steam vacuum refrigeration systems have become more popular than ever. They produce chilled water in the range of 40 F to 60 F for cooling process heat exchangers, air conditioning and the multitude of other applications where chilled water is required. The booster steam jet ejector draws off flash vapors and discharges them to the barometric condenser. The non-condensed materials are drawn from the barometric condenser by two more stages of steam ejectors and an inter condenser.

Another type of refrigeration system uses a surface condenser to replace the barometric condenser. Since the latter system does not mix the condensate with the cooling water, the condensate may be pumped from a condenser draw-off leg.

In addition to cooling water, flash cooling and concentrating of liquid solutions are two other applications for the steam vacuum refrigeration system. These systems are extremely simple in operation and rugged in construction. With simple automatic controls, they can function at excellent efficiency at all times of the year at all loads. Over-loading the system does not harm the equipment. The system will produce more refrigeration capacity at over-loads, but at a higher temperature than that for which it was designed. Most large capacity steam vacuum refrigeration units are installed outside and require no protection from the weather other than a protective coat of weather resistant paint. When indoor installations are required, the component parts can be arranged in almost any fashion to suite the particular space requirements. Steam vacuum refrigeration efficiently utilizes steam at pressures as low as 2 psig and sometimes lower.

FOR PUMPING AND MIXING

Steam jet ejectors can be designed to pump liquids and even finely divided solids for pneumatic conveying systems. In the latter service, they are becoming widely used to transfer fluidized catalyst with ease and a minimum of loss.

Liquid jet ejectors can also pump liquids with good efficiencies as can steam jet ejectors. In any case, the motive liquid pressure must be sufficiently higher than the suction and discharge pressures of the ejector to yield an economical flow ratio of motive liquid to load liquid. In addition to liquid pumping, liquid operated ejectors can be used to agitate, mix or meter liquid solutions.

Water operated ejectors are popularly used for fume scrubbing. A large volume of gas and vapor can be entrained at drafts from a fraction of an inch of water to about 10 inches of water and higher with good water economy. In these applications, obnoxious, corrosive or poisonous fumes can be sucked out of an enclosed area by means of a simple water jet ejector.

In addition to vacuum pumping, ejectors have found many applications for compressing fluids to pressures above atmospheric. Steam jet thermocompressors are a very efficient means of boosting low-pressure waste steam to a pressure where it can serve a useful purpose. High-pressure motive steam which might otherwise be throttled for use in an evaporator or heat exchanger can be used to actuate a steam jet thermocompressor. The thermocompressor can serve two purposes: (1) it throttles the high-pressure steam to the desired pressure and (2) it compresses low-pressure waste steam to a pressure where it is again useful.

Steam jet air compressors are useful for supplying compressed air in an explosion hazardous area where electrical equipment would have to be of explosion proof construction and relatively expensive. Compressed air at 20 psig for pneumatic controls is a typical application for steam jet air compressors.

It is often essential that an ejector be actuated by a gas or vapor other than steam. Excellent examples of this are the gas actuated ejectors used to compress low pressure manufactured gas from atmospheric pressure to the 15 or 20 psig pressure required for distribution mains. High pressure natural gas at about 100 psig or higher is used to actuate the ejector. The ejector serves to (1) compress the manufactured gas, (2) throttle the high pressure natural gas and (3) blend the two gases to the correct proportion.

HOW TO SPECIFY

When considering ejector equipment for an application, one should include all possible information relating to the performance required by the equipment. It is important, therefore, to mention here the type of information required by the manufacturers of ejector equipment. If the manufacturer has knowledge of the application, many design considerations will be evident and so it is advantageous and sometimes very important to reveal the application when writing specifications. The sample questionnaires accompanying this article will serve as a check list to anyone who must write ejector specifications. In many applications there may be additional information required; however, these questionnaires concern the essential data needed.

About the Author

F. Duncan Berkeley is a design and development engineer for Graham Manufacturing Co., Batvia, N. Y. He handles design, development and testing of steam jet ejectors, condensers, heat exchangers and related equipment. A graduate of Rensselaer Polytechnic Institute with a B.M.E. degree, he joined Graham in 1950. He worked in the Heat Exchanger division, Ejector Test department and Ejector Engineering division. The author of several published articles on ejectors and related equipment, Berkeley spent several weeks in Europe recently, observing progress on ejectors and heat exchangers.

Figure What an Ejector Will Cost

These data will help you size pre-condensers and inter-condensers, estimate ejector costs, and predict steam and water consumption

V. V. Fondrk
Elliott Company, Jeannette, Penn.

ONCE A CAPACITY has been established for a proposed vacuum system, the most economical route to take in pumping the load to atmospheric pressure must be chosen. At times, because of load and suction pressure conditions, there is little choice in the matter. Quite often, however, several choices are available and an economic evaluation must be made.

The cost of pumping a given quantity of vapors and gases from a sub-atmospheric pressure to atmospheric pressure with an ejector consists of the following:

1. Operating Cost
   a. Cost of steam used
   b. Cost of water used
2. Fixed Cost
   a. Cost of vacuum pump
   b. Cost of installation
3. Maintenance Cost

We will consider only operating cost and that portion of the fixed cost which covers the cost of the vacuum pump. Maintenance is seldom a significant factor when comparing several different ejector pumping systems for a given duty. Installation cost varies greatly depending on circumstances, and it is not possible to present realistic estimates for this cost.

Pre-Condensers. The first consideration in choosing an ejector arrangement is to determine if any of the load gases can be condensed in a pre-condenser. Where the dew point of the load gases is near or below available water temperature, or where load consists entirely of non-condensable gases, it is not possible to use a pre-condenser. When the dew point is high in relation to available water temperature, a pre-condenser should be used because it costs less to pump liquids than vapors. When the dew point of the load mixture approaches available water temperature, the choice is not clear; and it is usually necessary to compare two systems, one with and one without a pre-condenser, to arrive at the better arrangement for minimum total cost.

The two types of condensers available, direct contact (barometric) and surface types, differ considerably in initial and operating costs. For a given load, the direct contact condenser will cost less, use less water and cool non-condensable gases to a lower temperature (thereby decreasing size of ejector equipment serving or following the condenser). With contamination of cooling water a major consideration today, however, surface-type condensers are being increasingly used on ejector vacuum pumping systems.

Counter-current direct contact condensers are usually sized on basis of water flow. The Heat Exchange Institute standards on direct contact condensers specify maximum water ratings for various shell diameters. Down rating of these maximum water ratings is necessary at times when non-condensable gases are a high percentage of load. Similarly, some down rating may not be necessary if low absolute pressures are to be maintained with relatively cold water. In general, however, the size of a direct contact pre-condenser may be approximated with fair accuracy by calculating water requirements.

Cooling water required for a direct condenser may be calculated from the following formula:

$$F = \frac{Q}{(500)(R)} \qquad (1)$$

Where:
F=Water required, GPM
Q=Total heat transferred to cooling water, Btu/Hr
R=Temperature increase of cooling water, °F

Total heat, Q, consists of both sen-

TABLE 1—Water Ratings and Cost of Direct Contact Condensers

Shell Diameter (Inches)	Water Rating (GPM)	Approximate Cost (Dollars)
18	170	1,200
24	350	1,600
30	600	2,100
36	900	2,600
48	1,600	3,700
60	2,500	5,200
72	3,600	7,200
84	4,900	9,500
96	6,400	12,000
108	8,200	15,500
120	10,000	19,000

TABLE 2—Multiplication Factors for Cost of Direct Contact Condensers

Construction Material	Factor
Carbon steel	Basis
Type 410 stainless steel	2.25
Type 304 stainless steel	2.5
Type 316 stainless steel	2.75
Alloy 20 (1)	3.0
Alloy M (1)	3.0
Phenolic-asbestos plastic	2.5

(1) Composition of Commercial Alloys (percent): Alloy 20-Iron with 20 Cr, 29 Ni, 0.07 max C, 2 Mo, 4 Cu, 1 Si.
Alloy M-67 Ni, 30 Cu, 1.4 Fe, 0.1 Si, 0.15 C.

sible heat of load gases and heat of condensation of any condensable gases. The temperature increase of cooling water is usually set by the allowable approach to the dew point of the incoming load mixture. This difference between dew point of load mixture and outlet water temperature is known as the terminal temperature difference. For direct contact condensers handling non-condensable gases and water vapor only, its value depends on the percentage of non-condensable gases in the load. A good average value to use in estimating water requirements is 5 F.

Where condensable oil vapors are present in a load, water requirements and condenser size can be estimated by considering the non-condensable gases and water vapor only. Generally, condensable oil vapors have vapor pressures low enough to permit condensation before the dew point of the remaining non-condensable gas—water vapor mixture is reached. Some increase in water flow may be necessary where the oil vapors are a large part of the load and contribute significantly to the heat load.

Table 1 lists maximum water ratings for standard shell sizes of direct contact condensers. Approximate cost are given for carbon steel construction. Table 2 lists multiplication factors for units constructed of other materials.

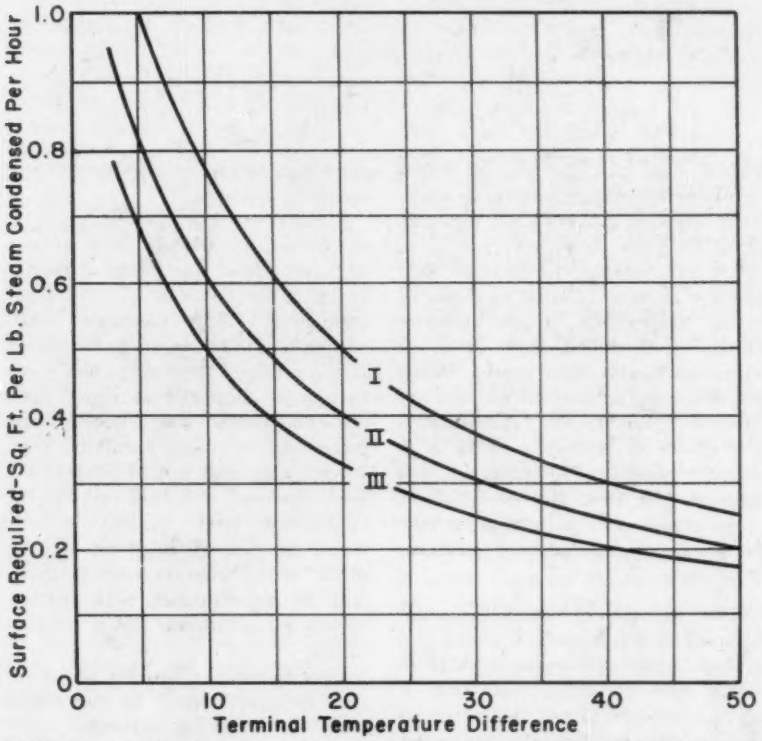


FIGURE 1—Surface area required for a fixed tube sheet pre-condenser depends upon the terminal temperature difference (dewpoint of the inlet vapor mixture minus temperature of water outlet). Curve I is for a heavy oil vapor load with non-condensables greater than 30 percent of load. Curve II is for a medium oil vapor load with non-condensables of 10-30 percent. Curve III is for light oil load with less than 10 percent non-condensables.

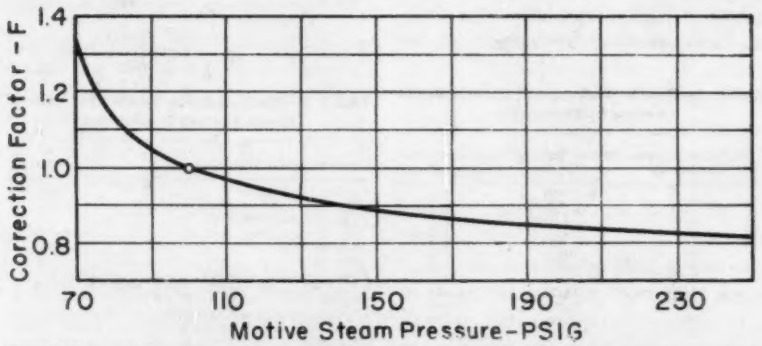


FIGURE 2—If the motive steam pressure is higher than design, less steam is required.

Sizing of surface-type pre-condensers is a balance between availability and cost of cooling water and cost of the condenser. Water requirements are calculated as for direct-contact condensers from formula I. However, the choice of terminal temperature difference to use represents a compromise between water usage and condenser cost. As terminal temperature difference decreases, water requirements also decrease, but surface area required to effect transfer of heat increases.

Figure 1 is a plot of surfaces requirements for condensing steam from a non-condensable gas-steam mixture in a fixed tube sheet pre-condenser. The curves are based on cooling non-condensable gases to a temperature 10 F above the inlet water temperature. Over-all fouling factor of 0.003, a common value for this service, is included for all curves. Since the temperature difference at one end of the condenser is plotted, and the other fixed, inlet water temperature is not a controlling variable. However, the curves lose some of their accuracy if designs are to be based on large increases in cooling water temperature (say, more than 40 F) or if outlet cooling water temperature exceeds 120 F.

Where appreciable condensable oil vapors are present in the inlet mixture, the curves in Figure 1 may be used by considering the steam and non-condensable gases only. Where condensable oil vapors contribute a considerable portion of the total heat load, some upward adjustment in surface area requirements may be necessary.

Actual cost of the pre-condenser can be determined, after surface area

requirements are established, by referring to current cost data on heat exchangers.[1, 2, 3]

Figure 1 is based on fixed tube sheet construction. Floating head pre-condensers will generally require more surface for equivalent performance. Temperature difference corrections for multi-pass water flow contribute to increased surface requirements for floating head units. Additional surface is required to compensate for the relatively inefficient wide baffle spacing used on vacuum units to keep pressure drop on shell side low. Both of these factors are minimized in fixed tube sheet units since there is considerably more latitude in baffle placement and flow patterns. Temperature cross-over problems are easily handled in fixed tube sheet units through use of longitudinal baffles. Similar arrangements are available for floating head units but add to cost. In general, considering increased surface and complexity, floating head, pre-condensers will cost about 30 percent more than equivalent fixed tube sheet units, for the same service.

Loads for sizing ejector equipment to serve the pre-condenser are calculated for conditions at the vapor outlet of the condenser. Non-condensable gases will be saturated with water vapor at the pressure and temperature existing at the vapor outlet. For counter-current, direct-contact condensers, the vapor outlet temperature is generally assumed to be 5 F greater than inlet water temperature, although higher values may be used for high non-condensable gas loadings. Pressure drop in a well designed direct contact unit will not exceed 5 percent of the inlet pressure to the condenser. For surface condensers a practical vapor outlet temperature is about 10 F above inlet water temperature and pressure drop should not exceed 10 percent of the inlet pressure.

Ejector Costs. The rest of this article will cover costs on ejector units where load gases are pumped to atmospheric pressure by an ejector. This data will be the same whether the ejector is serving a pre-condenser or directly connected to the process.

The simplest ejector available is the single-stage unit. Its use is generally limited to pressure above about

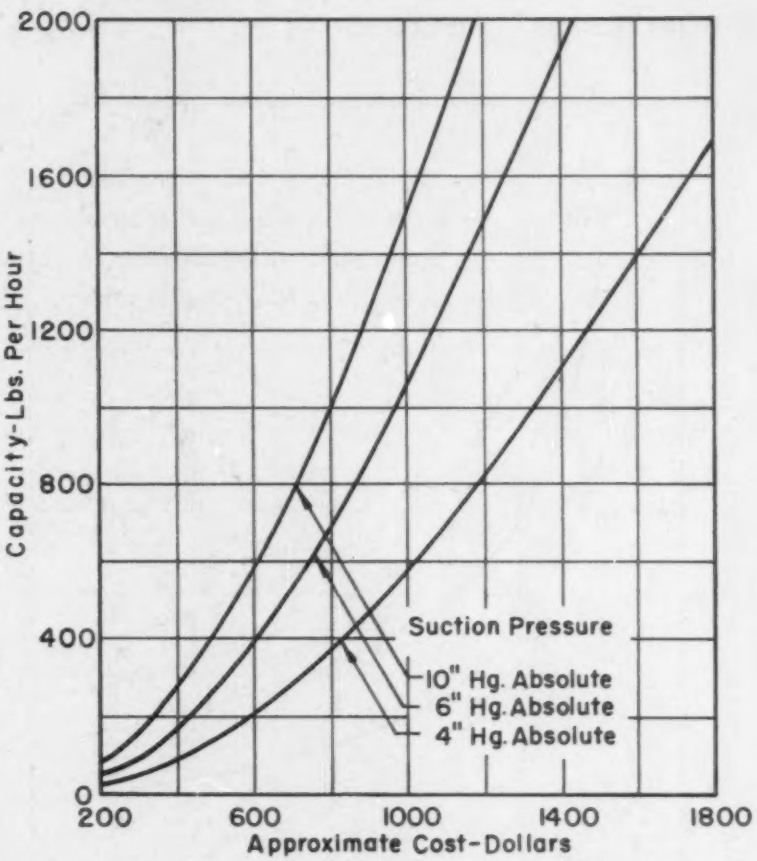


FIGURE 3—The approximate cost of a single-stage ejector is based on cast iron construction.

4" Hg abs. While aftercondensers are not necessary for proper operation of an ejector, they are often used to eliminate the nuisance of discharging quantities of steam to atmosphere.

Table 3 gives performance figures for single-stage ejectors. This table is based on 100 psig motive steam. Corrections for other steam pressures are given in Figure 2.

TABLE 3—Steam Requirements for Single-Stage Ejectors

Suction Pressure (in Hg abs)	Lb Motive Steam at 100 psig per Lb 70 F. Air Equivalent Load.
4	6.9
5	4.9
6	3.7
7	3.0
8	2.6
9	2.3
10	2.0
12	1.6

Costs for single-stage ejectors are plotted in Figure 3. These costs are based on cast iron construction. Steel construction will add about 30 percent to the cost of a single-stage ejector in smaller sizes, (6" vapor inlet or less) while in larger sizes steel construction will be equal to or less than cast iron in cost.

If an aftercondenser is required, water flow can be calculated from Equation (1) using a reasonable outlet water temperature. Direct contact aftercondensers are sized from data in Table 1. Size of surface type aftercondensers will depend on cooling water temperature, fouling factor and type of load. With normal water temperature, surface requirements will vary between 0.1 and 0.15 sq. ft. per pound steam condensed per hour, with the lower figure used for low fouling factors and relatively small non-condensable and oil vapor percentages in the load.

Two-stage ejectors are generally used in a range of pressure from 0.5 inch Hg abs. to 4 inches Hg abs. Two-stage units may be built as non-condensing units without an inter-condenser between the first and second stages. This eliminates need for

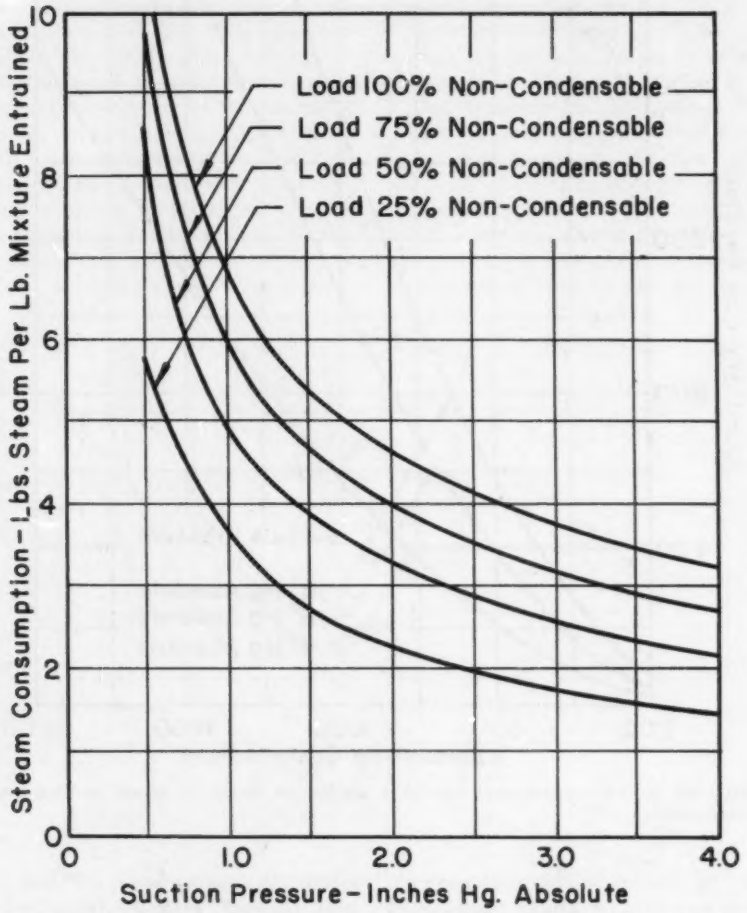


FIGURE 4—This steam consumption is based on a two-stage ejector using 100 psig steam and a surface type intercondenser using 85 F cooling water.

water and decreases installation cost. However, these units are relatively inefficient and use large quantities of steam. They are seldom used in oil refinery work except in smaller sizes or where steam usage is not important.

Performance of two-stage units with intercondenser varies widely with water temperatures, steam pressures and composition of load. Additionally, use of direct-contact intercondensers results in less water and steam requirements than when surface-type condensers are used. Figure 4 gives steam requirements for two-stage ejectors using surface-type intercondensers, 100 psig motive steam and 85 F. water. Approximate corrections for other motive steam pressure are obtained from Figure 2. Corrections for other water temperatures are plotted in Figure 5. Steam consumption for two-stage units employing direct contact intercondensers will be about 10 percent less than the values obtained from the curve for surface-type units.

Water required for two-stage units can be approximated by using Equation (1). Where an aftercondenser is employed heat load to use in calculating total water requirements includes latent heat of all the motive steam plus any water vapor in the load. Where an aftercondenser is not used, only about one half of the total motive steam need be used in calculating heat load since the second-stage steam will not be condensed by the cooling water. In calculating water requirements, reasonable outlet water temperature should be used. For surface units 120 F is commonly accepted as a maximum, and this figure also represents a good practical maximum for direct-contact type units.

The same factors that affect steam requirements for two-stage ejectors also affect cost of the unit, although not necessarily in the same proportions. No simple representation of cost is available that will accurately cover all combinations of steam pressure, water temperature, composition of load, and suction pressure. An order of magnitude figure of cost, in dollars, of a two-stage ejector with surface-type inter and aftercondensers can be obtained by totaling motive steam with water vapors in load and multiplying this figure by a factor of 2 to 3. The lower multiplication factor should be used for standard constructions (single element, steel ejector stages, fixed tube sheet condensers with copper alloy tubes and low fouling factors) and where available water temperatures are relatively low. These cost factors are applicable to larger units only (steam consumption 5,000 lb/hr or more). Cost of two-stage ejectors with direct contact inter and aftercondensers will run about 50 percent of the cost of a comparable unit with surface type condensers. Where aftercondensers are not required savings in cost amount to about 20 percent of the total cost.

Three-stage ejectors are generally used in a range of pressure from 0.2 inch Hg abs. to 2 inches Hg abs. There are several arrangements of condensing and non-condensing stages

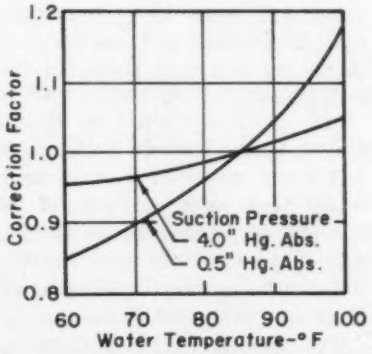
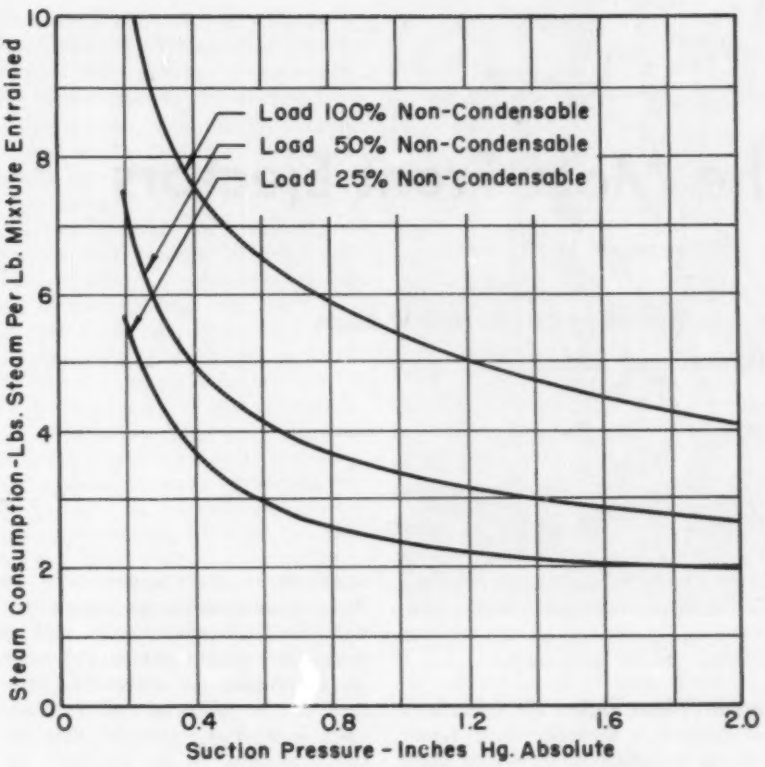


FIGURE 5—The steam consumption for a two-stage unit is reduced if the cooling water is lower than 85 F.



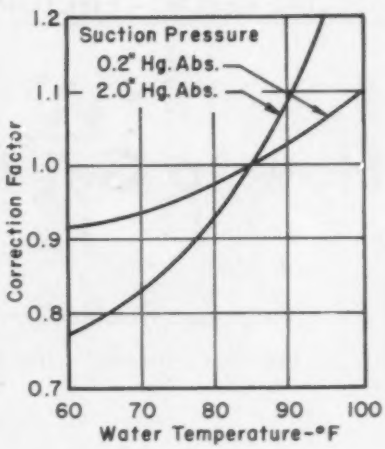


FIGURE 6—A three-stage ejector using 100 psig steam and two surface intercondensers using 85F cooling water will have the following steam consumption.

FIGURE 7—Here are the correction data for steam consumption of a three-stage unit.

available in making up a three-stage unit. The arrangement most commonly used in oil refinery work is the one employing two intercondensers. This is the only arrangement we will consider in this article.

The same variables affecting two-stage performance also affect performance of three-stage units. However, the effect on three-stage performance of such variables as water temperature and composition of load, is generally more pronounced than in two-stage units. Figure 6 gives steam requirements for three stage ejectors using two surface-type intercondensers, 100 psig steam and 85 F water. Motive steam pressure corrections are obtained from Figure 2, and approximate water temperature corrections are plotted in Figure 7. Steam consumption of three-stage units with direct contact intercondensers will be about 15 percent less than values obtained from the curves for surface-type units.

Water requirements can be estimated in the same manner as for two-stage units. However, for certain units the outlet water temperature is limited by interstage pressure used in the design and it is not possible to use a full 120 F outlet water temperature. Where aftercondensers are omitted, heat load from motive will be about 75 percent of total steam requirements.

Costs for three-stage units vary even more widely than for two-stage units. The approximation suggested for two-stage units can be used for three-stage units except that the multiplication factor should be 3 to 4. Again, units with direct contact condensers will cost about one half the cost of the unit for the same service using surface-type intercondensers. Omitting the aftercondenser will decrease over-all cost by about 15 percent.

Performance data given for two and three-stage ejectors shows an overlap in suction pressure. The choice of number of stages to use will depend on an economic evalution. Cost of steam and water must be compared with fixed costs to arrive at the installation that will give least cost. In general, high steam and water costs will favor use of three-stage ejectors. Low steam and water costs, coupled with short periods of time for amortization of equipment cost, will favor use of two-stage ejectors.

In summary, the choice of an ejector system for a given application can and should be reduced to a simple economic evalution. The result will be minimum pumping cost to maintain the desired vacuum.

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How to Get the Most From Ejectors

To insure trouble-free operation of ejectors, review these points concerning installation and inspection

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EJECTORS HAVE PROVED to be a very valuable device for use in many processes. They have taken their place as pumping devices, mixing devices, reactors, compressors and vacuum pumps. They are particularly advantageous where corrosive and erosive conditions exist. Their simplicity of construction allows the use of many materials which are precluded in units having moving parts. Their low cost makes replacement of corroded and worn parts economical where necessary, and maintenance and repair are therefore relatively low in cost, both in downtime and material. Proper selection of materials of construction, careful programing of replacement parts, and trouble-shooting by trained personnel can further reduce these costs.

Install Them Right. The installation of ejectors is normally quite simple due to the absence of moving parts, and relatively light weight. However, it is necessary to adhere to certain requirements in order to obtain satisfactory operation. An ejector is essentially a fixed-flow device. Once it is manufactured the nozzle and throat are of constant dimension so that units operate most satisfactorily at a fixed set of conditions. It is essential to adhere as closely as possible to the design conditions for operation of the unit. For high-velocity units, such as steam jet vacuum pumps and some jet compressors, the motive fluid pressure can be quite critical. In these cases it is always essential that the steam pressure be not less than the design pressure, with as little overpressure as possible in order to obtain optimum performance. It is also essential that the proper cooling water be supplied to any condensers involved in multi-stage ejectors. To achieve low maintenance requirements the motive fluid should be of as high quality as possible. Steam supplied to ejectors should be free from moisture and slightly superheated where available. Wet steam is very erosive, not only to the steam nozzle but also to the diffuser. Jets operating on other fluids may deteriorate from the corrosive action of untreated water, scaling from hard water, or erosion and fouling from dirty fluids. Steam nozzles will clog with loose scale and may also be coated with scale deposited from moist steam where carryover from the boiler is severe. This scale will restrict the orifice of the nozzle and require servicing. A strainer and separator should always be installed—directly at the inlet to the ejector.

Installation of ejectors is not critical so far as position is concerned. Some water jets should be installed with the motive fluid flowing vertically downward. This is true of low-draft ejectors such as fume scrubbers, high-vacuum units such as jet

Check List for Trouble-Shooting of High Vacuum Equipment

1. **VACUUM SYSTEM**
   - (a) Leaks (check gaskets)
   - (b) Plugging or restriction of vapor lines
   - (c) Temperature of vapors
   - (d) Accuracy of vacuum gage
2. **UTILITIES**
   - (a) Motive Steam
     - (1) Low or fluctuating pressure
     - (2) Wet steam
   - (b) Condenser Water
     - (1) Too little
     - (2) Too much
     - (3) Too hot
3. **EJECTOR PIPING**
   - (a) Barometric Leg (tail pipe)
     - (1) Leaks (check gaskets)
     - (2) Hot well clogged
     - (3) Clogged tail pipe
   - (b) Atmospheric discharge
     - (1) Clogged
     - (2) Condensate pockets
     - (3) Poorly centered gasket at discharge flange
4. **EJECTOR**
   - (a) Atmospheric Stage
     - (1) Clogged nozzle
     - (2) Worn or scaled diffuser
     - (3) Incorrect nozzle or diffuser
     - (4) Poor nozzle gasket
   - (b) Intercondenser
     - (1) Cool air to ejector (condenser top)
     - (2) Even curtains (no breaks)
     - (3) Clogged nozzles or trays
     - (4) Worn or broken trays
     - (5) Vacuum leaks
     - (6) Scale formation in air outlet connection
     - (7) Fouled condenser (deposits of process material)
   - (c) High-vacuum ejector (see atmospheric stage)
   - (d) Booster or pre-condenser (see inter-condenser)
   - (e) Booster, third, fourth, fifth stages (same as atmospheric stage, check in ascending order)

condensers, and water jet exhausters. Practically all other types of ejectors may be installed at any altitude without interference to performance.

The majority of steam jet vacuum pumps are installed at barometric height, especially when direct-contact condensers are used. It is essential that this be a full barometric leg to provide water removal from the condenser. Allowance must be made for the mixtures of air and water discharged from jet condensers in calculating the required height. It is also important that the barometric leg (tail pipe) be as straight as possible. It should be free from any horizontal runs where air entrained in the water can separate to cause discontinuities in the flow. In general, any ejector installation should allow for free flow of the fluid without odd arrangements which will cause turbulence and excess pressure drop in the piping. The supply pipes to liquid jets must be such as not to cause any tendency toward vortexing in the entrance chambers.

Ejectors are used in preference to other pumps because of their lower first cost and ease of maintenance. Proper installation can assist greatly in reduction of maintenance costs. It is almost too evident to require mention that installation for ease in removal or access to parts can greatly reduce the time required for servicing.

Proper installation for ease in running check tests to identify difficulties will reduce downtime and service cost. Among the accessories that should be installed on such units as steam jet vacuum pumps are pressure gages, located where they will give pressure at the inlet to the ejector; means of measuring the pressure at the various stages of multi-stage units; and isolating valves, or flanges to allow the insertion of blanks, for separating the ejectors from the process system. Any connections to vacuum units, such as barometric tail pipes or atmospheric discharge lines, should be installed with flanges at the outlet so that blanks can be attached for pressure testing of the complete vacuum system, including the ejectors. Where condensers are involved, a means should be provided for obtaining cooling water inlet pressure, and temperatures at both the inlet and outlet. In outdoor barometric installations some permanent means of access to the units themselves should be provided, without requiring open ladders and their attendant hazards. Safe catwalks at the ejector level are advisable so that units can be disassembled for examination and repair, without having to put up temporary scaffolding or to work from ladders.

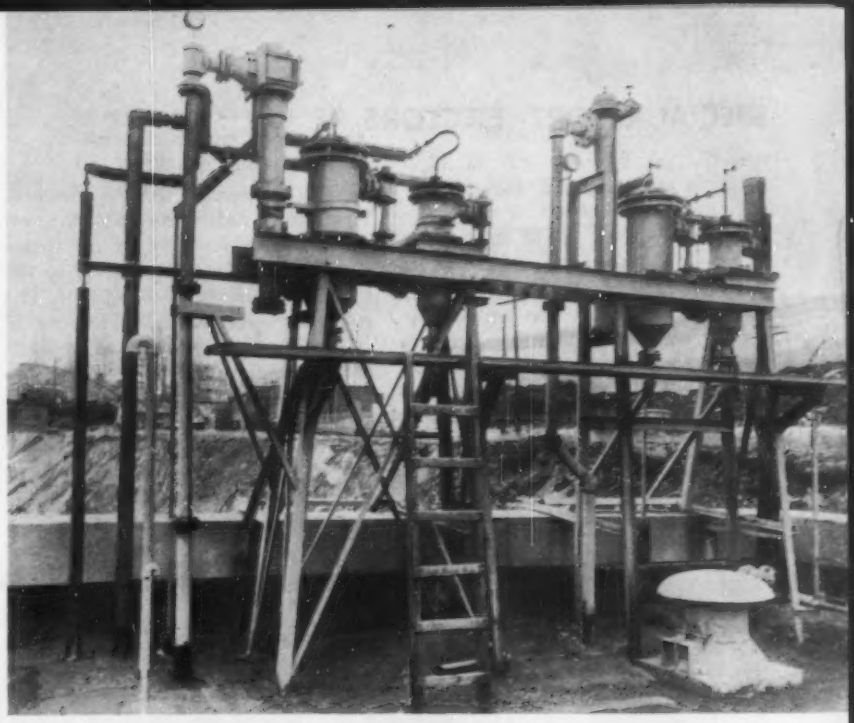


FIGURE 1—The cost of maintenance and repair for ejectors is low. Here is a view of two multi-stage units. The unit on the left has a carbon booster ejector followed by two condenser-ejector systems of special plastic construction. All components of the unit on the right are constructed from the special plastic.

Trouble-Shoot in Steps. The most costly feature of breakdown is the loss of production, rather than the actual cost of parts or maintenance time. As in curing all ailments, the first and most important problem is diagnosis. An orderly approach to finding the cause of the failure will save appreciable time and eliminate errors.

Step 1—Determine whether the fault lies with the vacuum pump or the system. This is accomplished by blanking off the suction to the ejector and operating the entire unit. If the no-load or shut-off condition approaches the minimum suction pressure of the ejector, then the fault lies in the system. This shut-off pressure would be approximately 2 in. Hg abs. for a single-stage unit, 0.25 to 0.5 in. Hg abs. for a two-stage, 1 to 3 mm Hg for a three-stage, and 100 to 200 microns for a four-stage. If the test shows the ejector operating satisfactorily at shut-off, it can usually be expected to operate satisfactorily at the load.

Step 2—Next check the system for leaks and correct. To determine the amount of air leak, approximate the total volume of the system, operate the ejector to secure a pressure somewhat less than 15 in. Hg abs. and then isolate the ejector from the system. Measure the time required for a rise in pressure in the vessel (say 2 in. Hg). It is essential that the absolute pressure does not rise above 15 in. Hg abs. during this time. The following formula will then give the leakage:

$$W_L = \frac{0.15\ V\ \Delta p}{t}$$

where W_L = Leakage, pounds per hour
V = System volume, cubic feet
Δp = Pressure rise, inches Hg
t = Time, minutes

If the volume of the system is not known, the leakage can still be determined, but two tests will be required. First, the test described above must be run. Then a known air leak must be introduced to the system. This can be done by means of a calibrated air orifice. A second test is made obtaining a new pressure rise and time. The unknown leak is then given by:

$$W_L = \frac{W'}{\frac{(\Delta p')}{(\Delta p)}\ \frac{(t\ \ )}{(t'\ \ )} - 1}$$

Where W' = Known leak, pounds per hour
$\Delta p'$ = Second pressure rise, inches Hg
t' = Second time, minutes

If the air leakage is greater than the load for which the jet was designed, then the alternatives are to correct the leaks or to use a larger ejector. The ejector must be large enough to handle not only the leaks but the normal load from the process.

Step 3—Assuming that the test indicates the ejector is not operating satisfactorily, the blank should be left in and the ejector utilities checked. First install calibrated steam gages (with pigtail syphon) on the steam chest or immediately adjacent to the inlet to each stage of the ejector. The operating pressure is normally stamped on the nameplate or parts of the ejector, and the pressure determined by the gage must not be lower than this rated steam pressure. If steam pressure checks satisfactorily, the steam should be checked for excess moisture. The drainage lines from steam separators should be checked to make certain they are draining properly through steam trap or bleeding through a valve. Open the discharge from the separator by means of a valve and let it bleed to see whether this makes any change in the operation. A bucket trap discharging in cycles may cause fluctuating steam pressures.

Step 4—Assuming that the steam pressures have been found satisfactory, all of the ejectors except the atmospheric stage should be shut off and the resulting vacuum read. If

Stainless Steel

Rubber Lined

Polyvinyl Chloride

Stoneware

Plastic

Ejectors can be made from a wide variety of materials—Thus they can be designed to

In general, materials of construction fall into categories of ferrous, non-ferrous and non-metallic. A wide variety of these materials is used in the manufacture of ejectors. For most ejectors they are limited to machinable materials, but in quantity production materials which can be formed by molding find considerable use.

Ferrous Materials. The most common ferrous material is cast iron, due to its low cost and corrosion resistance to many fluids. It is particularly suitable in cases where ejectors are operated intermittently, since it has high resistance to corrosion by combinations of atmospheric air and water. The 300-series stainless steels, usually type 304 and 316, are used frequently enough to be considered as standard materials. They are resistant to a wide variety of corrosion and, of course, have high limits relative to erosion and temperature. The carbon steels are used for some high-temperature noncorrosive service or in refinery service where cast irons are not acceptable. Some nonmachinable materials such as the silicon and nickel alloy irons may be used for high resistance to corrosion and erosion where close tolerances do not have to be maintained. They are applicable in some low-head devices such as mixing eductors, sump ejectors and heaters, but are not suitable for high-efficiency, high-velocity units. It is difficult to hold the proper dimensions without resort to expensive methods of machining such as grinding.

Non-Ferrous Materials. The bronzes are the normal standard non-ferrous materials. These should be of an acid-resistant grade with relatively low zinc content. They are used widely for eductors, heaters, water jet exhausters and diffusers of small steam jet vacuum pumps. In cases where erosion becomes more severe, and particularly with salt water, the copper-nickel alloys are used. They may be standard copper-nickel alloys or may be the harder varieties with small amounts of silicon. For more severe corrosive applications some of the proprietary metals such as the molybdenum-nickel and chromium-nickel alloys are employed. Titanium has been used successfully in nozzles and diffusers for resistance to hydrochloric acid. These materials also have relatively high erosion resistance.

Softer materials such as hard lead may be used for low-velocity ejectors but are not greatly used at the present time for high-velocity units such as steam jet vacuum pumps. It is normal to use an antimonial lead to eliminate cold flow and to improve the erosion resistance where corrosion does not require the use of pure lead. Chemical lead requires external support, usually cast iron or steel.

Non-Metallic Materials. These can be basically divided into ceramics and plastics.

Ceramics such as stoneware and porcelain are used. The difficulty in maintaining close tolerances, particularly with stoneware, makes their use for high-velocity compression units rather difficult. Some porcelain steam jet vacuum pumps are in use but the ability to reproduce these units limits them to relatively low performance characteristics. Materials of this type find extensive use, however, in lower velocity units such as eductors and low-draft water jet ejectors used as fume scrubbers.

Although not properly classified as a ceramic, glass is used for standard ejectors. Where quantity production allows the use of the proper molds and forms, shock-resistant glassware can be manufactured economically. It is used in water jet eductors and exhausters, steam jet syphons and vacuum pumps.

Plastic materials on the market today which are suitable for use in manufacture of ejectors come in a wide variety. The thermoplastic materials lend themselves more readily to fabrication of special units, particularly in the larger sizes. Unplasticized polyvinyl chloride is used for water jets, both as eductors and fume scrubbers, due to its high resistance to acid corrosion and relatively low cost. This material is easy to machine and fabricate, and is susceptible to molding where quantity production is involved. Its limitation, however, is in the operating temperature which prevents its use above 150 F. The phenolic resins will stand somewhat higher temperatures but because they are thermosetting materials they normally require expensive molds and their use is limited to quantity production. Where it is possible to machine the units from reinforced bar or tube, laminated phenolics may be used. They are remarkably erosion resistant when used as water nozzles for eductors and exhausters.

The halogenated polyethylenes have been used very successfully by machining the parts from rough moldings. The high cost of these materials, however, precludes their use unless other materials are unsuitable.

this pulls down to approximately 2 in. Hg abs., then this stage is operating satisfactorily. If it does not pull down to this vacuum, then either the atmospheric stage is at fault or there is a leak in the ejector unit. The atmospheric stage should be isolated by blanking off its suction and checking shut-off pressure as before. If this stage does not operate it should be checked for:

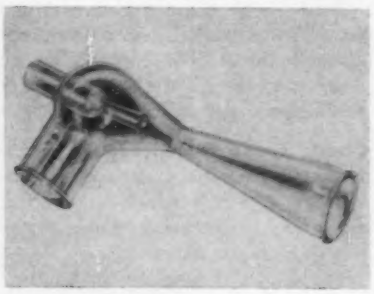
(a) Clogged steam nozzle, or steam strainer reducing flow through the nozzle. If nozzle inlet is red or black, look for a scale deposit which can be removed by careful scraping and subsequent polishing. If nozzles are graphite or plastic, measure the orifice to check for any shrinkage.

(b) Excess pressure at discharge of ejector. If low stage is discharging directly to atmosphere, check line to make certain that it is clear. Check for any places where condensate may accumulate to provide excess back pressure or pulsating back pressure. If discharge line is connected to hot well or to after-condenser, disconnect from ejector and allow ejector to discharge to atmosphere.

If the above points do not provide satisfactory operation, then the ejector must be disassembled. The nozzle and throat dimensions should be checked against the original manufactured dimensions. The nozzle and throat diameters should be obtained from manufacturer at the time of purchase and kept in the maintenance files, along with all of the data on original operating conditions. The diffuser should be examined for corrosion or wear. Pock-like irregular indentations indicate corrosion, streaks indicate combination of erosion and corrosion. Longitudinal wear marks in the steam orifice and diffuser are normally evidence of wet steam if corrosion is not present. A roughening of the inlet tapers through the diffuser, without any material change in diameter, may cause malfunctioning of the ejector. The diffuser should be smoothed out or replaced. It is normally more economical to replace a diffuser than to have it and the nozzle remachined. The actual material cost may be approximately the same, but the reduced downtime obtained by simply replacing the parts makes it the more economical procedure, and the original steam consumption will be retained.

Step 5—Assuming that the atmospheric stage ejector has been found to operate satisfactorily, it will be necessary to look for difficulties elsewhere. Inter-condensers operating under vacuum should be carefully checked for satisfactory operation. The inlet water temperature must be equal to or less than the design temperature. The tail pipe temperature should be approximately 20 F above inlet temperature for two-stage units, and 10 F for three-stage. These figures are general, and will vary depending upon design and amount of non-condensables present. The ejector manufacturer can furnish design temperatures. Malfunctioning of the condenser can occur with either too little or too much water. Too little water will be indicated by a high tail pipe temperature, and a high temperature in the head of the condenser before the suction of the atmospheric stage. Too much water may cause flooding of the condenser and would be indicated by pulsations in the atmospheric stage and discharge of

Lead Lined



Glass

withstand the conditions imposed by many kinds of fluids

One particular plastic has found considerable use in the manufacture of ejectors due to the ability to make low-quantity moldings without the use of pressure molds. The materal is molded by forming on a mandrel or in a casing depending upon the size and nature of the unit. It is a thermo-setting material requiring polymerization under temperature and pressure. Polymerization is performed in an autoclave so that pressure molds are not required. The base material is a phenolic resin or furfural alcohol resin with digested asbestos or carbon as filler. The phenolic resin has sufficient temperature resistance to make it suitable for use in steam nozzles at pressures up to 150 psig. All varieties may be used for most types of ejectors to produce the lowest-cost corrosion-resistant steam jet vacuum pump.

Glass fiber-reinforced plastics such as the polyesters are finding increasing application in ejectors. They are performing very satisfactorily in larger fabricated units such as water jet fume scrubbers and eductors. Some varieties are available with temperature tolerance up to 300 F, and have been used for the diffusers of ejectors and for direct-contact steam condensers. The molding techniques for this material are not costly, and in units large enough to fabricate from sheet the cost is low for a corrosion-resistant material.

Carbon is one of the non-metallics which does not fall under either the heading of a plastic or ceramic. For over 20 years ejectors have been manufactured from molded and machined graphite. The graphite is formed in bar or block and machined to the proper shapes and contours. The conventional tolerances can be maintained quite closely and machinability is excellent. After machining, the voids in the graphite (approximately 10%) are filled by successive applications of a resin. This material is forced into the pores as a monomer and polymerized in place under pressure and temperature. The product is known in the trade as impervious graphite. The material meets all of the temperature requirements for operation with steam up to 150 psig and over a wide range of corrosive conditions. It is applicable mostly in the small and medium-sized ejector range.

Linings. The use of linings for ejectors is not always possible. For low-velocity units, especially in the larger sizes, they prove quite economical. Such linings may be rubber (both natural and synthetic), polyvinyl chloride, baked phenolics, and lead. For small ejectors it is normally more practical to make the unit out of solid material rather than attempting a lining, due to small internal diameters. For high-velocity ejectors linings must be carefully considered due to the stripping action of the jets. Most of the linings will not stand temperatures which exist in high-vacuum exhausters —250 to 300 F when using 125 psig motive steam—and are therefore not usually considered. In certain cases such as large steam jet boosters operating in the range compressing to 2 to 3 inches Hg abs. the temperatures are well below 180 F and synthetic rubber linings such as chloroprene rubbers (CR) are used successfully.

water from that stage. If the atmospheric stage is removed from the condenser, this carryover of water would be indicated by scale deposit in the suction connection—which will reduce the area causing excess pressure drop. Water carryover can also be caused by a leaking tail pipe. Air rising in the pipe will prevent flow from the condenser and cause surging of condensing water. Look for leaks at the condenser outlet flange and at the surface of the water in the hot well.

Assuming that the utilities to the condenser are correct as to temperature and quantity, the condenser itself should be checked for malfunctioning. In the usual cylindrical condenser, water-steam contact is obtained by a series of trays which give curtains of water. Where these curtains strike the wall of the condenser there would be a uniform low temperature without any breaks. Where the water is free from the wall of the condenser there should be a uniform high temperature. The steam temperature should decrease toward the top of the condenser, and the water temperature increase toward the bottom of the condenser. The head of the condenser should be relatively cool, approaching the inlet water temperature by 5 or 10 degrees, so that the load to the atmospheric stage is as low as possible. High temperatures at this point, with adequate water flow, indicates by-passing of the curtains. This may be caused by clogging of the inlet distribution piece, either nozzle or trays, or failure or clogging of the subsequent trays. This would then indicate that the condenser should be disassembled and examined. Small condensers should probably be replaced, as most small cast iron condensers are not designed for ready access to the interior.

Step 6—Assuming that the condenser check indicates satisfactory performance, proceed to the stage immediately ahead of the condenser and examine it in the same fashion as specified for the atmospheric stage.

Step 7—The same procedure should be followed step by step from the atmospheric end of the multi-stage unit up to the highest stage in order to eliminate the difficulties.

Check These Points, Too—Miscellaneous—There are certain miscellaneous problems which may occur and affect performance. These things can be such points as:

(a) Material plugging or building up in the suction line. This may be due to too-small a diameter or simply because the suction flow contains gases or solids which will come out on the wall and reduce the diameter. This increases the pressure drop and increases the absolute pressure at the process apparatus even though the ejector may be operating satisfactorily.

(b) Possibility of filling up of the hot well with mud and so prevent proper drainage of condenser water from the tail pipes.

Other corrections which must be made cover the following, in the order of their frequency:

(a) Replacing the diffuser due to erosion or corrosion. In replacing any such parts new gaskets should always be used for all joints. It is good practice to replace the diffuser completely with a new part, rather than attempt to remachine and repair the existing diffuser. If the materials of construction are very expensive it may be advisable to remachine. However, if the downtime is expensive a replacement part should be used and the original part returned to the factory for remachining and held as a spare.

(b) Replacement of steam nozzles. Metal nozzles are inserted with a thin copper gasket which must be replaced for the original gasket whenever possible. If this is not possible, the old gasket should be annealed. In non-metallic units, the gaskets should also be replaced any time the nozzles are replaced.

(c) Replacement of inter-condenser. Normally the condensers are the last part to give out on these ejectors and in most cases their replacement would indicate complete replacement of the ejector unit.

Trained specialists are developed by some companies to handle the maintenance and repair of steam jet vacuum pumps. This training includes actual experience in the operation of ejectors and diagnosis of faults. Such individuals are then ready to assist the operators or maintenance men in diagnosing and correcting difficulties. Their experience also becomes of value in developing spare parts and maintenance programs in the plant. A valuable aid to their function is a small test stand where atmospheric stages can be tested without tying up the process equipment. Location of the test stand at the boiler plant insures adequate steam pressure. The equipment should include pressure and vacuum gages, and calibrated air nozzles.

The preceding discussion of trouble-shooting has been confined to high-vacuum ejectors. The same basic approach should be used with any ejector. It is good practice to keep the design operating conditions and original nozzle and throat dimensions on file with maintenance records. This will provide a guide for replacement schedules as well as being of assistance in trouble-shooting.

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Computer Gives Best Splitter Design

Fractionation towers need to be designed for optimum operation. Here are data on a pentane splitter to show you how this can be done

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IN GENERAL, a fractionator has narrow ranges of operating and design parameters which lead to optimum economic operation significantly better than operation at other conditions. One of the major decisions to be made by design engineers is the choice of these proper ranges. This choice will affect all of the physical design and operation economics and, therefore, the profits from the column.

In the past, optimum economic conditions have been developed through trial-and-error procedures and rules-of-thumb for fractionation systems that are common and well defined. However, greater diversification and higher purity of products, today, create many cases having no background of experience on which to draw for the optimum set of design and operation parameters. High speed digital computers then can aid the design engineer in this phase of fractionator design.

A sample case is presented here to illustrate the type of calculations, data, and results involved in the optimization problem. The sample problem shows the optimum economic operating conditions for a given pentane splitter to be as follows:

- Pressure—60 to 70 psia with air condensing or 40 to 50 psia with water condensing.
- Reflux Ratio—120 percent to 130 percent of minimum reflux.
- Feed Condition—Saturated liquid at its bubble point.
- Amortization—The amortization period is a major factor in choosing between the two types of condensing equipment.

TABLE 1
Sample Fractionator Cost Estimate

Pressure—75 psia
Feed—All Liquid
Reflux—125% Minimum

EQUIPMENT	Total Equipment Cost Dollars	Daily Amortized Cost Dollars	Daily Utility Cost Dollars
Column-Heat Treated	$323,300	$ 59	$
Reboiler	15,600	3	349
Feed Heater	5,000	1	19
Bottoms Cooler	200	*	1
Condenser-Air, 90 °F	105,700	19	1
Distillate Cooler	8,000	1	*
Pumps & Motors	1,100	*	1
Totals	458,900	84	371

EQUIPMENT	Area-Square Feet	Temp. Degrees F
Reboiler	3,585	203
Feed Heater	2,041	...
Bottoms Cooler	6	...
Condenser	12,325	191
Distillate Cooler	1,396	...
Bottom Tray	.....	203
Top Tray	.....	191

* Less than $0.50 per day.

SAMPLE CASE

The problem was to find the optimum economic set of operating and design parameters for a pentane splitter processing 10,000 barrels per day of feed (50 percent nC_5, 50 percent iC_5) with overhead purity of 95 percent and bottoms product purity of 85 percent. The individual datum used and the particular flow arrangement used are shown in Figure 1.

The cost estimation program used the methods proposed by W. L. Nelson in his series on "Costimating" in the *Oil and Gas Journal*. Cost Index Factors were for January 1, 1957. The cost estimate routine computes equipment costs for all manufacturing conditions and chooses the cheapest. A sample cost estimate is shown in Table 1 to illustrate the type of answers computed and the approximate magnitudes of the numbers involved. Table 2 gives the range of the costs involved, although maximum and

These computer programs may be separate or combined . . .

- **A tray-by-tray fractionator design program**
- **A fractionator column sizing program**
- **A cost estimate program**
- **An executive economic program**
- **Service routines and subroutines such as**
  - **(a) Data files lookup and curve fit program**
  - **(b) Multiple component minimum reflux program**
  - **(c) Optimum feed tray location program**

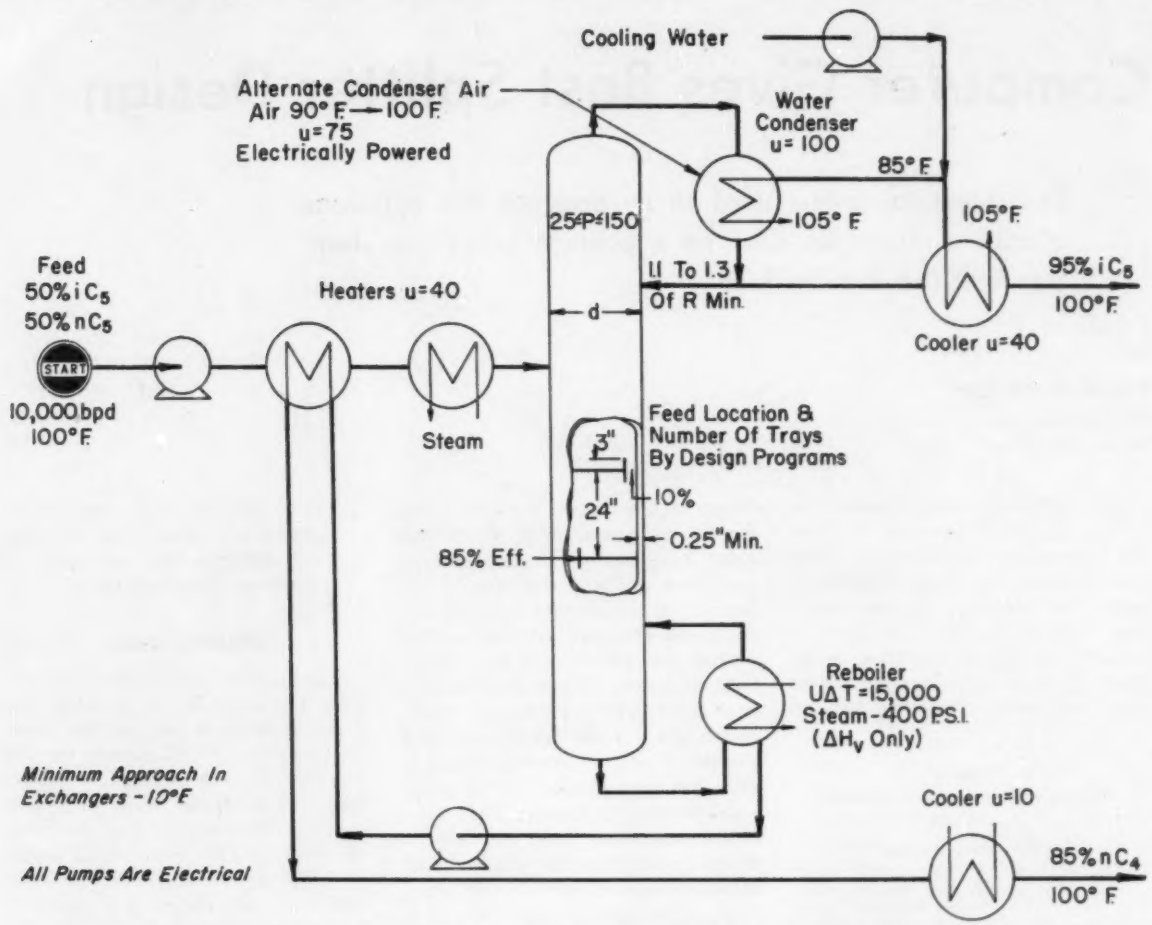

FIGURE 1—The 10,000 bpd pentane splitter is required to make overhead purity of 95% and bottoms purity of 85%.

minimums do not all appear in any one case.

The general effects of the variation of the parameters are shown in accompanying figures. The particular results found in the case of the pentane splitter are discussed as follows:

Variation of Costs with Pressure. The variation of investment and operating costs for the pentane splitter was studied for various pressures. Here is how the costs varied:

1. Total equipment costs—The graphs of total equipment costs as a function of pressure have a definite minimum (Figure 2a) which is independent of the condition of the feed, but, is not independent of the type condensing equipment used.

TABLE 2—Range of Values of Calculated Costs

EQUIPMENT	Maximum Equipment Cost-Dollars	Minimum Equipment Cost-Dollars	Maximum Daily Utility Cost-Dollars	Minimum Daily Utility Cost-Dollars
Complete				
Air	$795,000	$465,000	$458	$398
Water	584,000	350,000	370	314
Column	498,000	265,000	.....	.....
Reboiler	15,600	13,000	355	290
Condenser				
Air	420,000	95,000	38	29
Water	100,000	21,000	100	82
Feed Heater	5,600	1,500	23	7
Pumps & Motors	1,380	225	1	1

Cases in which a water condenser is used show the optimum operating pressure is in the range from 40 psia to 50 psia. The optimum operating pressure is in the range from 60 psia to 70 psia when an air condenser is used. In both cases, a pressure too low is farther from economic optimum than a pressure the same amount too high.

2. Individual equipment costs—The reason for the existence of an operating pressure giving minimum investment is shown by the graphs of the costs of individual pieces of equipment as a function of pressure (Figure 2c). The cost of the condenser at low pressures is high compared with costs of the rest of the equipment. Over the pressure range studied, the cost of the

"In general, a fractionator has narrow ranges of operating and design parameters which lead to optimum economic operation significantly better than operation at other conditions."

condensing equipment decreases rapidly at first and then more slowly. The reason for this decrease in cost is the increasingly favorable temperature differential in the condenser. The increasing heat duty in the condenser is overbalanced by this change in temperature differential. The costs of all other pieces of equipment increase as pressure increases.

3. Daily utility costs—All of the daily utility costs rise with increasing pressure. The total daily utility cost is nearly linear with pressure (Figure 2b).

4. Ambient air temperatures—Increasing the ambient air temperature has a much more detrimental effect on costs at low pressures than at high pressures. This occurs because of the lower condensing temperatures at lower pressures. At low pressures, a given change in ambient air temperature causes a larger percentage variation in the temperature differential than does the same change at higher pressures.

5. Optimum operating pressures—The results show that, for a given type condenser, there is a definite optimum operating pressure insofar as equipment costs are concerned (Figure 2a). However, when a decision is to be made between the two types of condensers, other factors must be considered.

The use of a water condenser results in a lower initial investment cost and a higher daily utility cost than does the use of an air condenser. If all other considerations are equal, the increased cost for delivered equipment with an air condenser would be balanced by the savings in utility costs in three to four years. In actual practice, the decision between the two types of equipment might be decided by other factors; such as rate of return on investment, amortization period and method, income tax laws, operating labor costs, local conditions at the proposed construction site, and availability of cooling water and electricity.

Variation of Costs with Reflux Ratio. The calculations show that the total cost of equipment decreases as the reflux increases (Figure 2f). The

These programs help find the best fractionator design . . .

Several calculation programs are necessary to find the optimum economic parameters of fractionating columns with a computer. Depending upon the computing equipment available and upon the relative sophistication of the computing group involved, some of these programs may be omitted and the steps involved done by hand.

A tray-by-tray design program utilizing heat, material and equilibrium balances is required to be flexible and general. Such a computer program should allow specification of feed, pressure, and key products purity or split, and should converge upon reflux rate, number of trays, and location of feed tray. In all cases, the program should also converge upon the split of all components present in the feed. The program should allow the options of multiple feeds and multiple draws, both liquid and vapor. For draws, total draw quantity and either draw tray or purity of one component in the draw should be specified. Feed entry should be optionally by isothermal flash, adiabatic flash, or by flashing a given fraction. Options on condensers should include total or partial condensation. A general program should require no preliminary guesses on product streams or draw streams compositions, but should converge upon the answer from a "cold" start. A program of this type allows the flexibility needed to enable the design engineer to pick the particular set of parameters which the problem dictates and thereby eliminate multiple trial and error solutions.

The column sizing program should give the minimum necessary column radius as determined by the individual tray conditions and flows as found in the fractionator solution. This program should be able to find this radius for any of the common types of fractionating equipment such as bubble cap trays, perforated trays, valve trays, etc.

The column cost estimate program should compute the cost of the completely equipped column including all peripheral equipment such as exchangers, pumps, motors, etc; all daily utility costs; and a daily amortized equipment cost based upon company amortization payout policies. Labor costs for erection, transportation, and foundation costs are highly dependent upon location and are difficult to estimate. However, for comparison between cases, these costs can be omitted without causing any significant error in choosing the optimum case.

The executive economic program directs and schedules the other programs to arrive at the optimum economic design. This optimum is chosen on a minimum daily utility and investment cost basis. The executive program should change the parameters in the other programs and supply data for the changed parameters. The executive routine may utilize any one of several different methods to seek the optimum case. All of these methods resolve into two types. In one type, one parameter at a time is optimized. In the other type, several or all of the parameters are optimized at the same time. Variation of all parameters at a time is probably preferable because this results in fewer total calculations and gives a more reliable optimum when some of the parameters are interdependent. The operation of the excutive program obviously may be by hand operation and, except in the case of computing centers with the largest computers, probably will be.

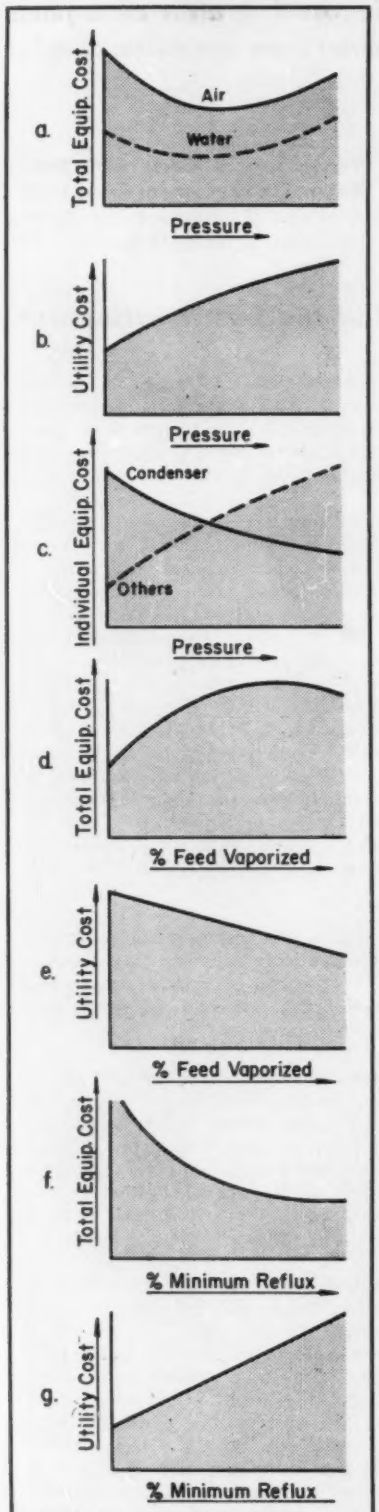

FIGURE 2—The effects of the variables for the pentane splitter are discussed in separate sections.

major decrease in equipment costs has been realized when 120 percent of the minimum reflux has been reached. The daily utility costs increased with increasing percentage of minimum reflux ratio (Figure 2g). Therefore, any reflux ratio in the range from 120 percent to 130 percent of minimum would be approximately equal economically because a slight savings in equipment costs will be counterbalanced by an increase in utility costs. Above 130 percent of minimum reflux, the daily cost increases because the decrease in equipment costs is less than the increase in daily utility costs. The optimum pressures are, in all cases, the same as previously stated.

Effect of Variation of Utility Costs. Varying utility costs had no effect on optimum economic conditions. However, they did show the sensitivity of cost estimates to the utility prices.

1. **Steam**—Variation of steam costs resulted in linear changes in daily utility costs. A change of \$0.01 per 1,000 pounds of steam changed the cost of reboiler steam an average of \$15.67 per day and the feed heater steam cost an average of \$9.33 per day.

2. **Cooling water**—Within the range of costs investigated, a change of \$0.01 per million BTU per hour duty resulted in a change of \$6.00 per day in water condenser costs.

3. **Electricity**—There was no change greater than \$0.50 per day with a change in electricity costs of \$0.002 per kwh.

Effect of Fraction of Feed Vaporized. Three cases of feed entry conditions were studied. They were with liquid feed at the bubble point, with 50 percent vapor feed, and with vapor feed at the dew point. As the fraction of feed vaporized increased, total equipment costs increased to a maximum and then decreased slightly (Figure 2d). The daily utility costs decrease slowly as the fraction of feed vaporized increased (Figure 2e). Therefore, the case with the feed at its bubble point is the optimum of the three cases studied.

Effect of Total Daily Cost. The total daily cost of equipment and utilities, D_c, is

$$D_c = I_d + U$$

where I_d = daily amortization cost
U = daily utility cost
if straight line amortization is used

$$I_d = \frac{I\text{-}S}{365A}$$

where I = total investment cost
A = amortization period, years
S = salvage value

If A is less than some given value, D_c will be less for a system equipped with a water condenser. If A is more than the given value, D_c will be less with the air condenser equipment. This "changeover," when included in a complete economic study, could serve as the basis for a choice between the two types of condensing equipment.

Errors. In the sample calculations, some difficulty was experienced in finding thermodynamic data that were consistent over the range of temperatures and pressures used. This difficulty could lead to an exaggeration of the effects of the parameters studied, but is not of sufficient magnitude to cause any error in the general trends of the parameters. Since this study was limited to a particular case, any extension of the results to other cases should be made with caution.

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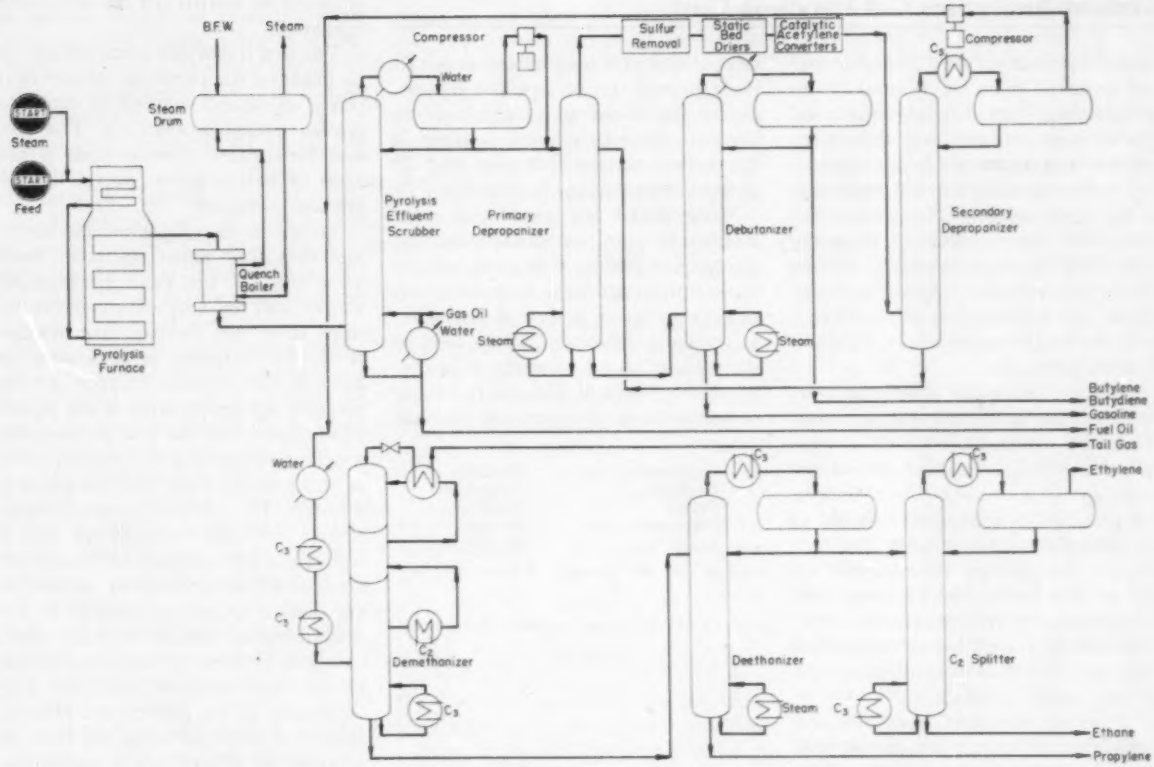

FIGURE 1—A typical ethylene process achieves cracking of a petroleum feed and then separation of the products.

Stream Analyzers Cut Ethylene Cost

There are many examples of instrumentation justification. The ethylene process is presented here as one example

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THE ETHYLENE process is one of many important processes in the petroleum, chemical, and petrochemical fields for which savings can be made by adequate instrumentation. The importance of the process is shown by the increased production of ethylene in the past several years. The projected future market indicates a continued increase, so producers are constantly striving to increase their yield at a minimum of cost. For this reason the process has a tremendous instrumentation potential; especially since an increase in efficiency can yield a high monetary return. Here is an example which shows a pay-out of less than four months.

A typical process for producing high purity ethylene is shown in Figure 1. Basically, the process is a cracking of petroleum fraction feed stocks, and fractionation of the cracking products. Feed is cracked in the pyrolysis furnace. The cracked products are partially cooled in the steam reboilers then finally cooled in the scrubber column. The fuel oils are separated from the cracked products

in the pyrolysis effluent scrubber and are removed from the system. Water is extracted from the overhead and the cracked products are then compressed and introduced into the primary depropanizer for the beginning of the fractionations. The primary depropanizer sends overhead a stream containing hydrogen, methane, ethane, ethylene, acetylene, propane, and propylene are extracted in the overhead, and the bottoms contain C_4's and heavier products.

Sulfur is removed from the overhead of the primary depropanizer. Then the overhead is fed to a catalytic acetylene converter where the acetylene is converted to ethylene in the presence of hydrogen, then fed to the secondary depropanizer. The bottoms of the primary depropanizer are fed to the debutanizer where the heavy saturates are extracted as a bottoms product and fed to a gasoline line, and the C_4's are withdrawn as the overhead product.

Overhead products from the secondary depropanizer are compressed, and after water extraction, fed to the demethanizer. Bottoms from the secondary depropanizer are fed back to the primary depropanizer.

The demethanizer begins the low temperature portion of the process. Here hydrogen and methane are extracted, and these gases are bled off as tail gas in the overhead. Bottoms are fed to the de-ethanizer. The resulting overhead products from the de-ethanizer are fed to the C_2 splitter, and the bottoms are taken off as propylene.

The final split of ethane and ethylene is made in the C_2 splitter, the overhead being taken off as pure ethylene, and the bottoms as pure ethane.

Pyrolysis Furnace Instrumentation. Points for measurement were chosen for their importance in improving the over-all efficiency of the process. The first point of measurement, the output of the pyrolysis furnace or the quench boiler, is of great importance.

The purposes of the measurements at the furnace output are to, (1) monitor hydrogen and methane since their output should be kept at a minimum because their value as products is low, (2) monitor ethylene since its output should be high, at least 25 percent, although this figure can reach 29 percent, and, by re-cycling ethane, can be increased to as much as 33 percent. Normal ethylene output is 25 percent on the first pass and 29 percent when ethane is recycled.

Since there are usually a great number of pyrolysis furnaces feeding the quench boiler, it is quite advantageous to monitor the output of each furnace to make sure it is operating at optimum efficiency. If the feed to the furnace is, for example, naphtha, we could expect to find the following constituents in the pyrolysis furnace output:

Hydrogen	Propane
Methane	Propylene
Ethane	Butadiene
Ethylene	Butane
Acetylene	Butylenes

and a low percentage of heavier fractions.

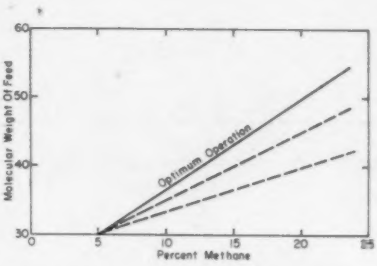

FIGURE 2—For optimum cracking, the molecular weight of the feed should be related directly to the methane content of the cracking products.

The density or molecular weight of the feed must be measured. It has been shown that for optimum cracking the molecular weight or density of the feed should be directly related to the methane content of the cracking products. This straight line relationship (shown in Figure 2, with dotted lines showing inefficient operation) should be used to determine what methane output results from efficient process operation. For example, if the feed has a molecular weight of 30, the quantity of methane which should result from optimum operation is approximately 5 percent. Another very important factor is governed by the molecular weight of the feed, that is, the heat required for optimum cracking. The molecular weight is approximately inversely proportional to the required heat, and if the feed is subject to change it is necessary to change the operating temperature to maintain an efficient operation.

The first important measurement to be made on the pyrolysis furnace output is methane content in order to govern optimum cracking. The second important measurement is the ratio of ethylene to ethane in the cracked products.

To obtain the proper percent methane operating point requires both knowledge of the feed molecular weight and the ethylene-ethane ratio, since these two factors are interrelated. For example, it is possible to increase the ethylene output by increasing the temperature of the pyrolysis furnace, but this will increase the methane output and the over-all value of the product from the process will decrease. Thus, it is important in optimizing the cracking process that a high ratio of ethylene to ethane be maintained, while keeping the methane content as low as possible. In the re-cracking of ethane to make ethylene, the cracked products contain additional methane, and the true optimizing of the process can only be assured through adjusting the ratio of ethylene to ethane while measuring the concentration of methane.

The pyrolysis furnace output can be analyzed by mass spectrometry techniques, Orsat measurements, or gas chromatography. It remains to evaluate which method is the most desirable.

- Employing mass spectrometry has the advantage of giving an almost continuous reading. However, the mass spectrometer will crack the components even further, and the readout is not a true indication of the percentage concentration of the original constituents. It is therefore necessary to calibrate the mass spectrometer for each constituent present, and the computer must solve a series of differential equations to arrive at the original analysis of the sample.
- The Orsat analysis employs a grab sample technique subject to human error and requires expert knowledge to measure some of the constituents. For example, it is difficult to differentiate between ethylene and propylene, and it is also difficult and lengthy to measure hydrogen. Orsat analysis is not conducive to measuring saturates and is by no means continuous.
- Gas chromatography is well suited for this application. It cannot be considered continuous, as a complete

analysis is made and recorded every 12-15 minutes, but it is highly reproducible and presents a true picture of the analysis without benefit of further computation.

The biggest problem in measuring the output of pyrolysis furnaces is in the sampling system. Present in this sample are the heavy fractions as well as heavy unsaturates which must be extracted before the measurement can be made. These heavy fractions and unsaturates will plug a mass spectrometer, will coat an infrared instrument, will clog the gas chromatography columns, and even have an effect on the Orsat equipment. Thus, these heavy fractions must be extracted prior to measuring the C_1's through C_4's in the sample regardless of the method of measurement. This sample handling problem has been solved and successfully applied for gas chromatography.

In the application of gas chromatography it is advantageous to use a split column which is capable of taking the low boilers and storing them in a second chromatograph column. The instrument will then measure the high boilers as they come out of the first column in the following order: propane, propyene, acetylene, butane, the butylenes, and butadiene. Quite often only propane, propylene, and acetylene are measured, and then the column is reversed and the C_4's are measured as one component. After this measurement, the low boilers which have been stored in the second column, are measured; these are hydrogen, methane, ethane, and ethylene. It is possible to further separate the butylenes at this point if necessary, but in the process of making ethylene this measurement is not required to achieve efficient operation. The monitoring of the methane content can be achieved with this measurement as can measurement of the ethylene-ethane ratio. Relatively simple means can be employed to obtain the ethylene-ethane ratio figure directly in either pneumatic or electric analog form.

It is quite common to have the ethylene load on the process vary, thereby requiring a change in the operation of the pyrolysis furnaces either by shutting down one or more, or operating them at reduced output. It is possible, by properly controlling the furnaces, to lower the output of all the furnaces to meet the demands while still maintaining a high efficiency in the system. In fact, it is possible by lower operation points to obtain a higher percent yield in this manner while the total output will be decreased, meeting the demand requirements. To install proper control of the pyrolysis furnaces it is necessary to know the molecular weight or density of the feed, the rate of flow of the feed, the temperature of the furnace and, of course, the constituents of the cracked products.

With such instrumentation and by applying a proper control system to the furnace it is possible to modify the process and measure other ratios, thereby maximizing the propylene output of the process and in some cases even the acetylene output. The versatility of this system lends itself to these modifications and has been quite valuable in the operation of the process.

Instrumentation of Fractionation Steps. Following the process through, the cracked products are cooled and then go through several fractionating operations. The overhead products coming from the pyrolysis effluent scrubber should be checked for water content prior to their entering the compressor to make sure the water extraction system is properly operating. No measurements are suggested on the primary depropanizer, but it is important to measure both the overhead and the bottoms products from the debutanizer to assure it is operating at its optimum point. The overhead should be monitored for saturates to make sure they are not being withdrawn into the C_4 stream, and the bottoms should be monitored for the unsaturates, mainly the butylenes and butadiene. Measurement of the butylenes at this point can be achieved but is not recommended as the sampling system is complex and the measurement is not considered critical for the proper operation of the process. The measurements on the debutanizer can be effectively made by gas chromatography.

Another very important measurement to make is in monitoring the efficiency of the acetylene converter to assure the acetylene entering the secondary depropanizer is of very low content or completely absent. The presence of acetylene in ethylene acts as a poison when the ethylene is used in the manufacture of polyethylene. It is important that the acetylene content of the stream entering the secondary depropanizer contain less than 10 parts per million of acetylene. This is an excellent application for infrared analysis.

The overhead from the secondary depropanizer is then compressed and after water extraction is fed to the demethanizer. This begins the low temperature portion of the process, where the extraction of water is very critical. If water vapor is allowed to remain in the process and enters the demethanizer in quantities as low as 10 parts per million, it is possible that a freeze-up will occur in the demethanizer and result in product loss. Therefore, it is recommended that the water content of the feed to the demethanizer be monitored for the presence of water vapor.

In the demethanizer hydrogen and methane are extracted, and bled off as tail gas. The extraction at this point is very critical. It is the last chance in the process to extract methane and yet maintain all of our ethylene in the end product. There are several ways to instrument this portion of the process. Infrared can be used to measure certain constituents in the overhead and bottoms on the demethanizer, de-ethanizer, and C_2 splitter.

On the demethanizer the overhead would be monitored for the presence of ethylene to make sure that valuable product is not being wasted in the tail gas line. The bottoms would be monitored for the presence of methane to assure methane is not carried over into the de-ethanizer from which it would eventually end up in the ethylene stream.

The overhead of the de-ethanizer would be monitored for propylene and the bottoms would be monitored for ethane to make sure the de-ethanizer is operating properly. Ethylene should not be allowed in the propylene stream nor should propylene be found in the overhead, thereby ending up in the ethane stream.

Finally, the C_2 splitter can be monitored in the overhead and bottoms to make sure the final split of ethane and ethylene is operating at optimum efficiency. The application of two infrared instruments each on the demethanizer, de-ethanizer, and C_2 splitter can be extended to include control of the units. These instruments in a sense are acting as high-low alarm operating points on the unit to obtain optimum operation.

It is possible, however, to approach

the low temperature portion of the process from a different aspect. Again, the application of gas chromatography can be quite valuable and result in lower instrumentation cost.

Three of the six analysis points would be instrumented as previously mentioned. An infrared instrument would monitor the demethanizer overhead for ethylene to make sure valuable product is not lost. A second infrared instrument would monitor the bottoms for ethane. A third infrared instrument would monitor the de-ethanizer bottoms from the C_2 splitter for ethylene, assuring proper splitter operation.

One gas chromatograph would replace the other three infrared instruments in the previously mentioned system. The gas chromatograph would monitor propylene in the C_2 splitter overhead to be sure that no propylene entered the C_2 splitter from the de-ethanizer. The chromatograph would analyze the C_2 splitter overhead for ethane which would ensure proper splitter operation. In addition, the chromatograph would measure other components, particularly methane and ethylene.

Analysis Readout. It is possible to gather the analytical data from the instruments that have been placed on this process in a data handing system to further automate the process and yield greater savings. It is also possible to use the gas chromatograph on control. First in monitoring the overhead of the C_2 splitter for methane the temperature of the demethanizer can be controlled. In monitoring for the presence of propylene the temperature of the de-ethanizer can be controlled. And third, by monitoring for ethane in the overhead of the C_2 splitter the temperature of the splitter can be controlled. Thus, there are many combinations of instruments that can be placed on this portion of the process which can be used for control as well as analysis.

Economics of Instrumentation. Now, how will the instrumentation placed on this process pay off? Ethylene yields of at least 25 weight percent may be produced in the pyrolysis furnace effluent. The ethane produced from this pyrolysis and extracted from the C_2 splitter can be fed back to the pyrolysis furnace and cracked to yield approximately 4 additional weight percent of ethylene. The C_3 fractions amount to approximately 4 percent of the yield and contain 90-95 percent pure propylene; propane-propylene splitting is usually not necessary. In the event that propylene is going to be used in the production of linear polypropylene or other propylene products it can be monitored for purity. The C_4 fractions coming from the overhead of the debutanizer are over 95 percent unsaturated and contain a high percentage of butadiene; the bottoms product of the debutanizer is a high octane gasoline.

If the process is set up so the ethane from the C_2 splitter is recracked, a 1 percent increase in yield represents a 3.4 percent increase in the over-all efficiency of ethylene manufacture. This 1 percent increase in yield is conservative. There have been many instances where this 1 percent increase has been exceeded by a surprising amount, resulting in even greater savings. From the plants that have been designed and built or are being built it is estimated that the average output would be approximately 320,000 pounds of ethylene per day. A 1 percent increase in yield will increase the dollar production by approximately $650 per day, $19,500 per month, or over $235,000 per year. This is on increased production of ethylene alone by the measurements described above.

There are other intangible savings which have not been listed because they are hard to estimate. These are refrigeration load, compressor load, shut-down time because of freeze-ups, and other factors which yield further savings. The cost for the instrumentation and the required sample handling system suggested for this process would amount to approximately $70,000. The estimated cost savings for one year is in excess of $235,000, resulting in a payout for the instrumentation of less than 4 months.

Substantial savings can be made by partially instrumenting the process, with full instrumentation being installed after the operating personnel have convinced themselves of the possible savings that can be made. The instrumentation on the process which results in the greatest savings for the dollar investment and results, of course, in the shortest payout is in the analysis of the pyrolysis furnace output.

Another important analysis is the concentration of acetylene in the converter output to make sure the ethylene will not contain any acetylene; this acetylene can poison the polyethylene process if the ethylene is used for this purpose. Avoiding one shutdown because of freezing in the demethanizer can easily pay for the hygrometer equipment necessary to monitor the level of water vapor in the demethanizer feed. The other recommended instrumentation on the demethanizer, de-ethanizer, and C_2 splitter will quickly pay for itself as any incorrect operating points will allow methane to enter the final product or valuable ethylene or propylene to be taken off as tail gas. All these applications can be justified on their own merits. ##

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Stanford B. Spracklen is associate director of research and engineering for the Process Instruments division, Beckman Instruments, Inc. He is responsible for the development of continuous operating analytical instruments for the process industries. Spracklen joined Beckman in 1956 after 13 years as supervisor of instrument research and development for Union Carbide Chemicals Co., where the first industrial gas chromatograph was developed under his direction. He was previously with Cities Service Oil Co., and Atlas Powder Co. He has authored many technical papers on gas chromatography and its uses in the process industries.

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New Hydrogen Sulfide Corrosion Curves

Recent laboratory data improve reformer corrosion rate prediction

E. B. Backensto and J. W. Sjoberg
Socony Mobil Oil Co., Inc.
Paulsboro, N. J.

ADDITIONAL LABORATORY data have permitted revision and extension of previously published iso-corrosion rate curves for high-temperature, hydrogen-hydrogen sulfide. Two new charts show the maximum corrosion rate expected over a wide range of hydrogen sulfide concentration and temperature likely to be encountered in petroleum catalytic refining processes utilizing hydrogen. From a practical standpoint, these charts are in agreement with the results reported by other investigators.

Figure 1 shows the new curves for the 0-5 percent chromium steels and Figure 2 shows the new curves for the chromium-nickel austenitic steels. The major variables plotted are temperature and hydrogen sulfide concentration with curves showing constant corrosion rate. The pressure variable is confined to the range of 175-500 psig because limited data at 0.1 percent hydrogen sulfide by volume and 985 F indicate that corrosion rate is unaffected by pressure in this range. Actually, most of the data below 1000 F were obtained at 450-500 psig while above 1000 F they were at 175-200 psig.

The iso-corrosion rate curves in Figures 1 and 2 represent an interpretation of laboratory tests of greater than 150 hours exposure. These curves show the *maximum* corrosion rate to be expected at a given operating temperature and hydrogen sulfide concentration in a hydrogen-containing stream. Numerous Socony Mobil tests at various locations in commercial reforming units have demonstrated the validity of these laboratory design curves. These curves

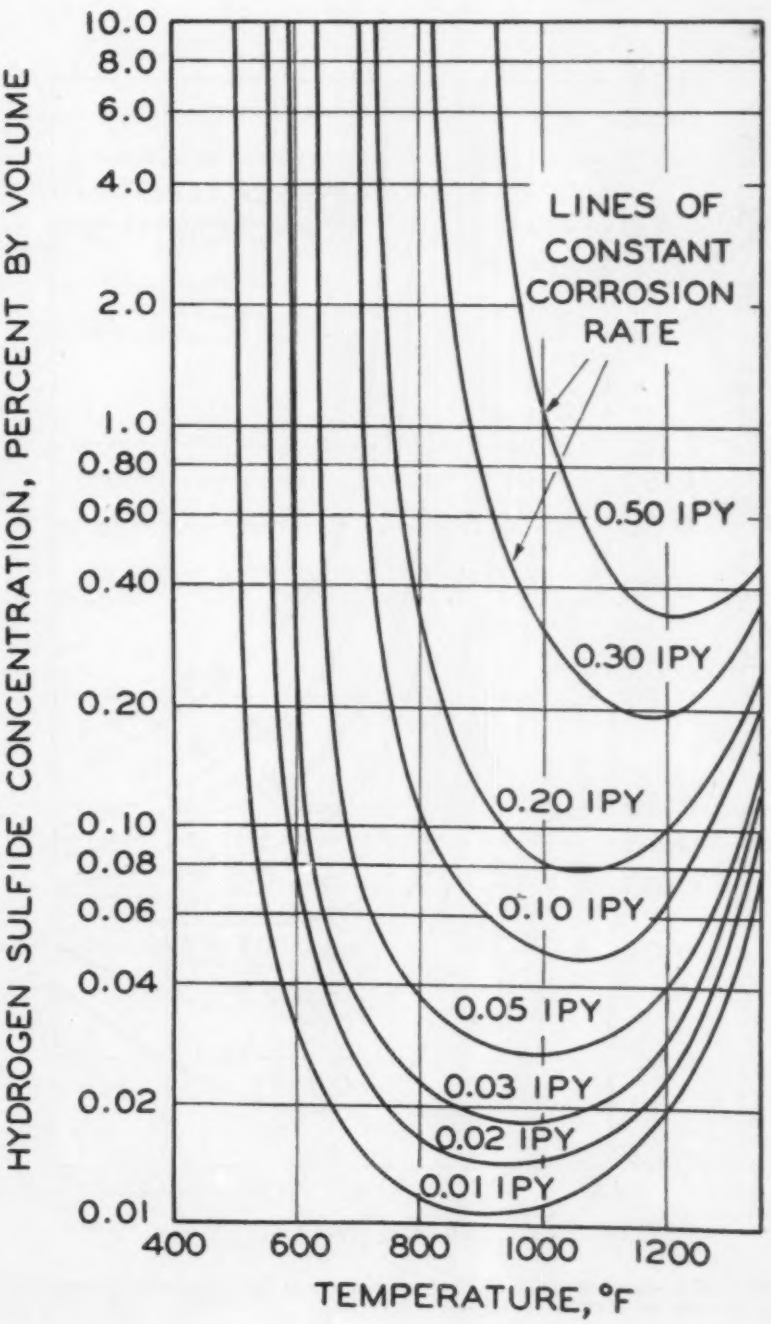

FIGURE 1—Curves show the effect of temperature and hydrogen sulfide concentration on corrosion rate of 0-5 percent chromium steels.

New Hydrogen Sulfide Corrosion Curves . . .

These charts are reported to be practical because it's easier to find the percent H_2S than the H_2-H_2S ratio

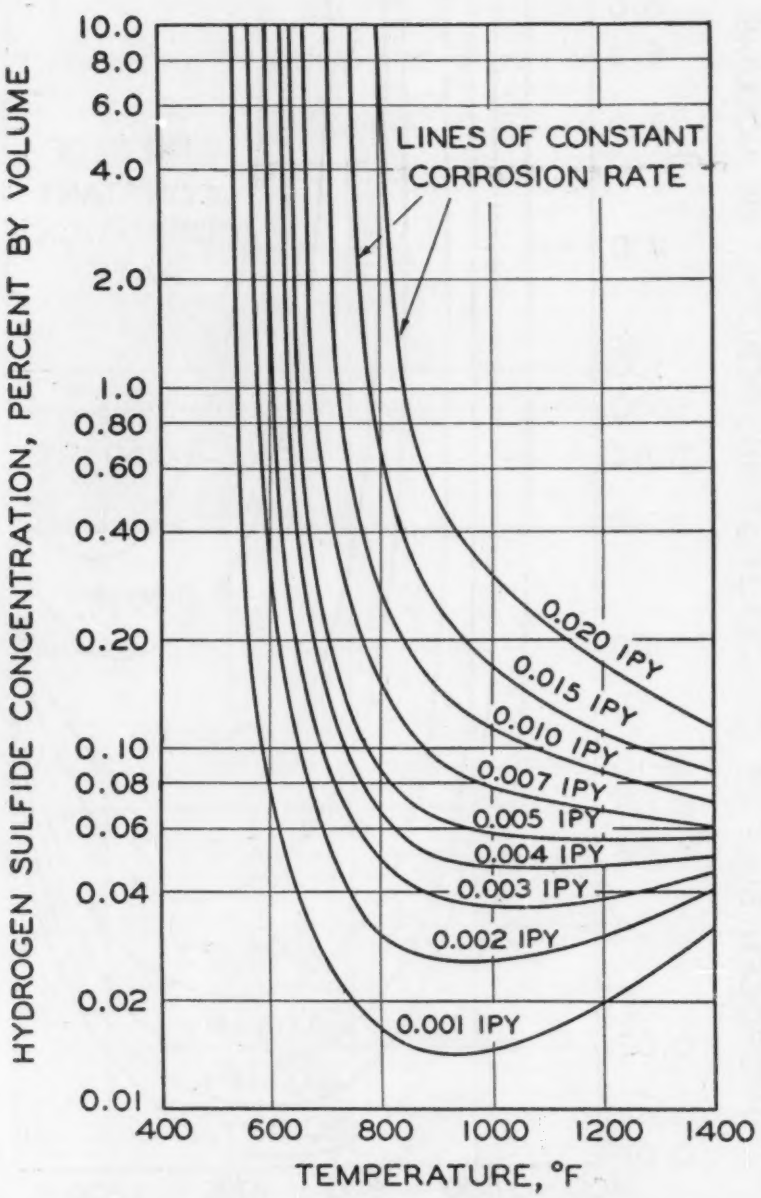

FIGURE 2—Curves show the effect of temperature and hydrogen sulfide concentration on corrosion rate of chrome-nickel austenitic steels.

may not predict the corrosion rate at the outlet of a naphtha pretreater or catalytic desulfurizer because the presence of minor constituents in the stream appears to hinder the corrosion mechanism.

The new curves in Figure 1 indicate that, in general, corrosion rates below approximately 0.07 ipy will be obtained at milder conditions than would have been predicted from the old curves. At most conditions, the new curves in Figure 2 predict somewhat higher corrosion rates than the old curves.

For most conditions, the iso-corrosion rate curves in Figure 1 may be used for the group of 0-9 percent chromium steels.

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Heat Transfer Nomographs

Part 2–Gas density, mass velocity and log mean ΔT

PART 3–Correction factor for film velocity and Reynolds number

Part 4–Prandtl number for liquids and gases

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NOMOGRAPH NUMBERS 6, 7 and 8 are extremely useful for determining: (1) correction factors for the film viscosity, (2) Reynolds number for liquids and (3) Reynolds number for gases. Determination of these factors are basic to heat transfer calculations.

Correction Factors for the Film Viscosity—In several heat transfer equations, the term $\left(\frac{\mu_s}{\mu}\right)^{0.14}$ is used.

FIGURE 6—Correction factors for the film viscosity.

Where: μ_s, Viscosity at the solid surface temperature μ, Bulk viscosity of the liquid.

The use of the Nomograph No. 6 can be extended beyond the values of μ, and μ_s given in the scales, by multiplying or dividing both values by multiples of 10.

Example: Find the term $\left(\frac{\mu_s}{\mu}\right)^{0.14}$ for a NaOH 50 percent solution at 165 F., if the temperature of the wall is 275 F. The viscosity of this solution at 165 F. is 8.7 centipoises and at 275 F. is 0.75 centipoises.

Solution: Multiply both values by 10, because one of the values is outside the scale. Then use the values 87 and 7.5. Using Nomograph No. 6 find that $\left(\frac{\mu_s}{\mu}\right)^{0.14}$ is 0.71.

Reynolds Numbers for Liquids—Nomograph No. 7 solves the formula:

$$Re = \frac{DG}{\mu} = \frac{4DW}{\mu\pi D^2} = \frac{4w}{\mu\pi D} = \frac{4 \times 12w}{2.42\,\pi\mu' D'}$$

$$Re = 6.32\frac{w}{\mu' D'}$$

Where: w, Flow in lb./hr.
D', Inside diameter, inches
μ', Viscosity, centipoises

Example: 8,000 lb./hr. of water at 54 F. flow through a ¾ inch Std., (I.P.S. 40) pipe.

Find the Reynolds number. The viscosity of water at this temperature is 1.23 centipoises.

Solution: Using Nomograph No. 7 gives a value of Re of 50,000.

Key : w — D : L

L — μ : Re.

Reynolds Number for Gases—Nomograph No. 8 solves the formula:

$$Re = 6.32\frac{w}{\mu' D'}$$

Where: w, Flow of gas, lb./hr.
D', Inside diameter, inches
μ', Viscosity of the gas, centipoises

Example: 7,250 lb./hr. of air at 60° F. flow through a 4½ inch Std., (I.P.S. 40) pipe. Find the Reynolds number.

The viscosity of air at this temperature is 0.102 centipoises.

Solution: Using Nomograph No. 8 Re is found to be 1,000,000.

Key : w — D : L
L — μ : Re.

TO BE CONTINUED

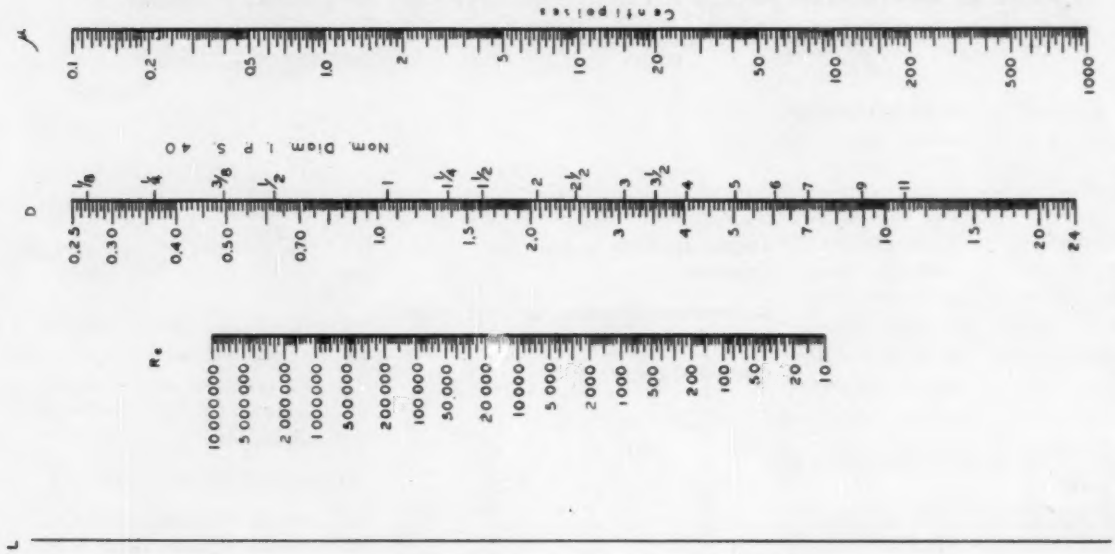

FIGURE 7—Reynolds number for liquids.

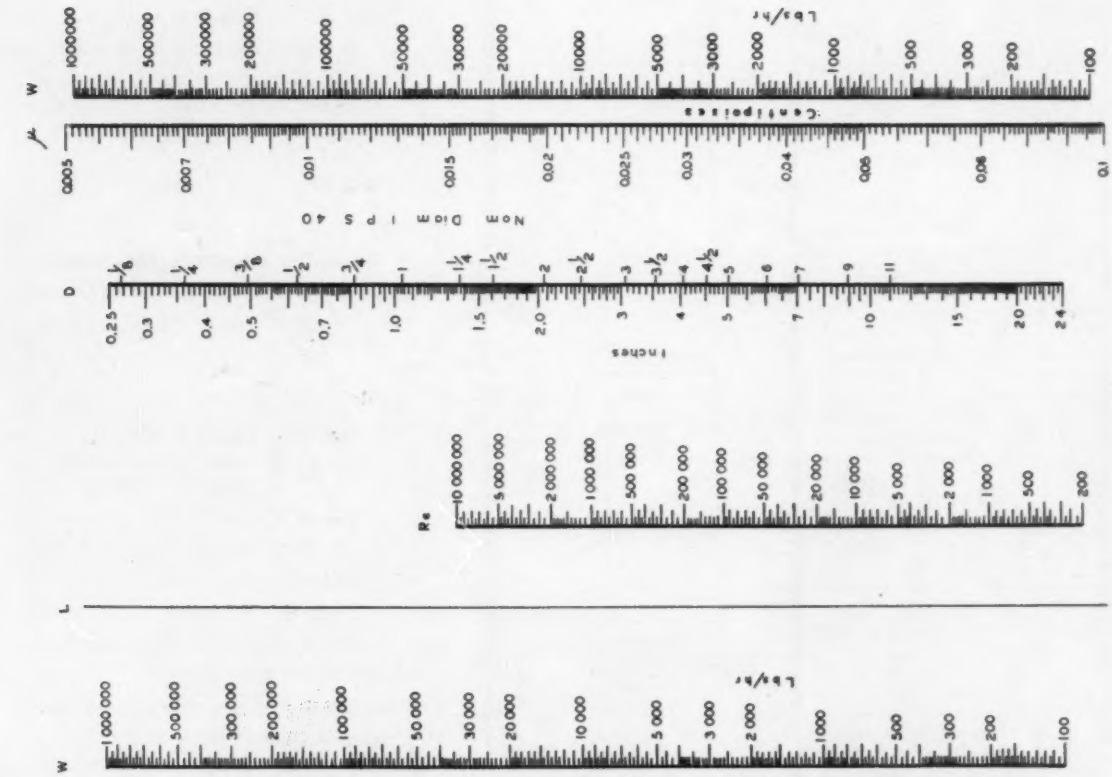

FIGURE 8—Reynolds number for gases.

How CO_2 Removal Plants Are Working

Operating data from first two plants show successful use of the hot potassium carbonate process to natural gas

Robert O. Palo, Honolulu Oil Corporation,
John B. Armstrong, Standard Oil Company of California, Taft, Calif.

SUCCESSFUL APPLICATION of the hot potassium carbonate process to natural gas is shown in the operating data from the first two units. Built in 1957, these plants are located at Taft, Calif.—the AP-2 plant of Honolulu Oil Corporation and the 1-C plant of the Standard Oil Company of California, Western Operations, Inc.

AP-2 Plant. The flow diagram for the AP-2 plant is shown in Figure 1. The hydrocarbon absorber discharge gas, containing approximately 8 percent carbon dioxide, is compressed from 100 to 400 psig. A portion of this 400 psig gas stream is fed to the bottom of the contactor to be treated counter currently with a 20 percent potassium carbonate solution. The treated gas, approximately one percent carbon dioxide, is blended with the non-treated gas so that the resulting mixture will meet pipeline specifications. To maintain a constant carbon dioxide content in this blended gas stream, a carbon dioxide analyzer continuously resets the flow controlling the amount of gas to be treated. A ratio controller on the volume of treated gas controls the potassium carbonate circulation rate.

The blended gas stream is then cooled and scrubbed prior to dehydration. The condensed water collected in this scrubber is returned to the carbon dioxide removal plant for use as make-up water.

The spent potassium carbonate solution is controlled at the bottom of the contactor by a liquid level control valve and returned to the regenerator where the carbon dioxide is rejected.

The regenerated potassium carbonate solution is pumped to the contactor by means of a two-stage 3,570 rpm centrifugal pump.

Heat for the regenerator is furnished from the engine jacket water system by means of vapor phase cooling, which produces fifteen pound steam. The use of vapor phase cooling on the engine jacket water system serves two purposes: cooling the engines and furnishing process steam at no additional operating expense. One disadvantage of this use is that the engine jacket water system limits the steam pressure, which in turn reduces the available mean temperature difference in the reboiler. This reduction in MTD can be overcome by additional heat transfer surface.

The bottom tray on the regenerator is a chimney type tray. The liquid from this tray passes through the regenerator reboiler and re-enters the column below the chimney tray. Vapors pass up through the chimney

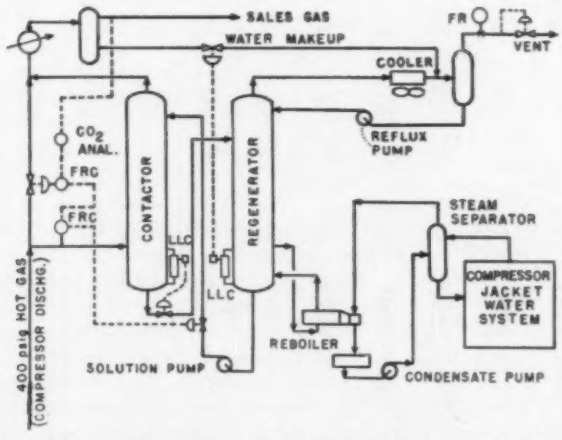

FIGURE 1—Flow scheme at AP-2 carbon dioxide removal plant: CO_2 content reduced to less than 1%.

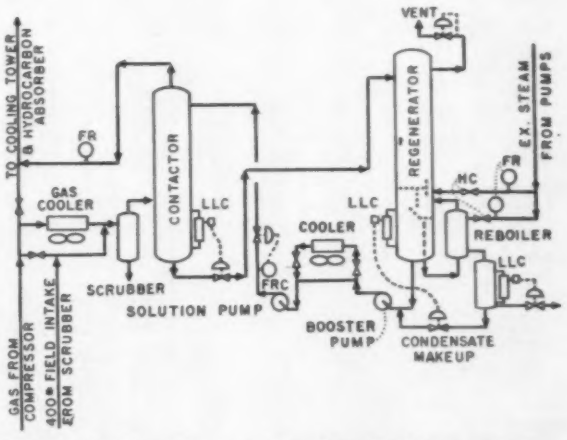

FIGURE 2—Flow scheme at 1-C carbon dioxide removal plant. Entire gas stream is processed here.

tray and the liquid falls into the bottom of the regenerator. This bottom section of the regenerator serves two purposes, one in maintaining a proper NPSH for the centrifugal pump and the other of providing a liqiud surge space.

The liquid from the chimney tray enters at the bottom of the reboiler through two nozzles, and the combination of liquid-vapor leave the reboiler through one nozzle. On any future installations, this nozzle arrangement would be reversed to reduce the exit velocity across the exchanger tubes.

The overhead from the regenerator is cooled and scrubbed. The water collected is used for make-up water and for flushing water on the mechanical seal of the solution circulation pump.

Materials of construction for the plant are carbon steel except for the perforated trays in both the contactor and the regenerator which are 304 stainless steel; the solution pump, the liquid level control valve with its adjacent piping and bypass, are of 316 stainless steel. Both vessels were stress relieved, however, the plant piping was not. The reboiler on the regenerator is of carbon steel with steel tubes.

The regenerator is a 42½-inch internal diameter vessel with fifteen 14-gage 304 stainless steel perforated plate trays on a 24-inch spacing. There are 2,060 3/16-inch holes per tray, blanked to 1,330 exposed holes per tray.

The contactor is a 30-inch internal diameter vessel with twenty-three 14-gage 304 stainless steel perforated plate trays on 24-inch spacing. There are 900 3/16-inch holes per tray.

Both columns have 2-inch weirs.

Operating data for the AP-2 plant under various test conditions are given in Tables 1, 2, and 3.

1-C Plant. The 1-C plant carbon dioxide removal facilities are located on the intake side of the gasoline extraction facilities. This location had several advantages; (1) A large portion of the gas stream flows directly from the compressor discharge to the CO_2 extraction plant, eliminating the necessity for complete cooling of this stream; (2) Existing gas cooling facilities were used to cool contactor discharge gas; (3) This location permitted utilization of a previously installed dehydrator without modifica-

TABLE 1—Tests Without Surface Active Material (AP-2 Plant)

	Design	A-1	A-2	A-3	A-4
RATES					
Gas to Cont. MCF/D	4,340	5,533	5,533	5,533	5,533
Sol'n. To Cont. GPM	108	103	94	72	56
CO_2 Reject MCF/D (Metered)	.....	241	233	221	213
Steam to Reboiler lbs./hr.	2,580	2,766	2,887	2,989	2,976
ANALYSIS					
% CO_2 Inlet	10	7.4	7.2	7.8	7.8
% CO_2 Outlet	*	3.6	3.2	3.8	4.1
FT^3/Gal.	.....	1.63	1.72	2.13	2.64
FT^3/Lb. of Steam	.....	3.62	3.36	3.08	2.69
Equivalent % K_2CO_3	40	34.6	35.8	37.3	34.9
Rich Sol'n. % Conver.	.....	.....	.....	.....	.....
Lean Sol'n. % Conver.	.....	38.9	32.0	33.0	26.5
Sp. Gr.	1.40	1.296	1.300	.....	1.264
PRESSURES					
Contactor Base, psig.	400	380	380	382	381
Regen. Top Press., psig.	0	2	2	2	2
Regen. Base, psig.	.....	8.5	9.0	9.5	9.0
TEMPERATURES					
Contactor					
Gas To °F.	285	274	273	276	273
Gas Fr. °F.	250	.....	.....	.....	.....
Liquor To °F.	235	226	226	227	226
Liquor Fr. °F.	245	229	229	230	229
Regenerator					
Top °F.	230	215	214	214	215
Liquor To	245	.....	.....	.....	.....
Liquor Fr.	235	226	226	227	226
Reflux	.....	74	79	77	79
REMARKS		*Blended Gas 5% CO_2			

TABLE 2—Tests With Surface Active Material (AP-2 Plant)

	1	2	3	4	5	6A	6B	7A	7B	8A	8B	9	10	11
RATES														
Gas to Cont. MCF/D	5,133	4,129	6,570	8,265	6,090	5,742	5,655	5,700	5,481	5,916	5,916	2,610	4,350	1,305
Sol'n. to Cont. GPM	120	108	108	109	110	101	101	71	71	70	70	91	91	90
CO_2 Reject MCF/D (Metered)	341	294	367	386	304	341	341	287	287	249	249	177	208	106
Steam to Reboiler Lbs./Hr.	2,917	2,977	2,884	3,034	1,150	2,946	2,946	3,009	3,009	1,300	1,300	1,250	1,250	1,250
ANALYSIS														
% CO_2 Inlet	7.8	7.8	7.9	7.9	7.9	8.0	8.1	8.0	8.0	7.9	7.9	7.8	7.8	7.6
% CO_2 Outlet	1.8	1.3	2.7	3.9	3.1	2.5	2.3	3.7	3.2	4.0	4.2	1.3	3.4	0.1
FT^3/Gal.	1.90	1.90	2.36	2.46	1.92	2.33	2.33	2.81	2.81	2.47	2.47	1.29	1.54	0.82
FT^3/Lb. of Steam	4.88	4.10	5.32	5.30	11.00	4.85	4.85	3.96	3.96	7.95	7.95	5.90	6.95	3.55
Equiv. % K_2CO_3	20.5	21.8	21.3	22.3	22.2	21.1	21.8	23.5	23.4	24.2	23.7	....	....	....
Rich Sol'n. % Conver.	66.5	63.5	75.3	64.4	68.4	72.5	72.1	72.0	71.0	67.8	72.0	....	....	....
Lean Sol'n. % Conver.	40.3	36.3	38.4	36.1	45.2	36.8	36.5	32.2	37.5	39.8	38.6	....	....	....
Sp. Gr.	1.194	1.204	1.207	1.207	1.207	1.208	1.215	1.225	1.229	1.225	1.222	....	....	....
PRESSURES														
Contactor Base, psig	395	392	392	392	390	392	395	390	390	395	395	350	375	375
Regen. Top Press., psig	2	1.8	1.8	2.4	2	2	2	1.7	2.0	1.5	1.5	1.2	1.2	1.0
Regen. Base, psig	7.8	8.0	8.0	8.0	7.0	8.0	7.5	8.0	8.0	6.0	6.0	6.0	6.0	6.0
TEMPERATURES														
Contactor														
Gas to °F.	279	286	285	286	280	276	281	285	288	289	289	254	270	267
Gas Fr. °F.	.....	219	223	225	217	223	223	224	224	219	219	210	210	201
Liquor to °F.	226	226	227	227	222	226	227	227	227	223	223	218	218	220
Liquor Fr. °F.	232	232	233	233	227	233	234	234	232	231	231	220	220	222
Regenerator														
Top °F.	205	205	205	204	200	204	204	204	205	199	199	198	190	202
Liquor Fr. °F.	226	226	227	227	222	226	227	227	227	223	223	218	218	220
Reflux	106	108	114	116	99	103	104	112	121	105	105	81	87	91

REMARKS
Silicone anti-foam agent added for all tests.

tion; and (4) Removal of carbon dioxide and hydrogen sulfide on this plant intake should result in a lowering of corrosion rates in the gasoline plant facilities.

The flow diagram for the 1-C CO_2 removal plant cycle is shown in Figure 2. Four hundred psig compressor discharge gas is delivered through an air cooled gas cooler to the contactor intake scrubber. 400 psig wet field intake gas enters the system just ahead of the scrubber. The gas cooler was installed to permit regulation of the inlet gas temperature and to assist in knocking out entrained lube oil and heavy hydrocarbon fraction ahead of the contactor. At this plant, the full gas steam (approximately 38,000 Mcf per day) is processed through the contactor. The treated gas is delivered to high pressure gas cooling sections and then to the hydrocarbon absorber.

The liquid level control valve at the base of the contactor, all piping adjacent to this valve and all bypass piping and valves, are 316 stainless steel. The spent solution is flashed through the control valve into the top of the regenerator. Carbon dioxide and steam from the regenerator are vented directly to the atmosphere through a pressure control valve.

The bottom of the regenerator is divided into two sections. Solution from the bottom tray flows into a blind section connected to the base of the thermosyphon reboiler. Solution, vapors and steam from the reboiler vent back into the same section of the regenerator. Excess liquid from this section overflows a weir into the other section which acts as a solution surge. Stripping steam on hand control may be used as heat in this reboiler and/or injected as live steam below the bottom tray of the regenerator. Liquid level in the surge section controls the make-up steam condensate which maintains solution concentration.

Solution from this surge is pumped through a low head, low speed, single stage booster pump to furnish suction for the main circulating pumps. These are two-stage, 3,600 rpm, centrifugal pumps which deliver solution through a rate control valve to the top of the contactor. A solution cooler, originally installed to permit controlling temperature, is now bypassed. The regenerator and contactor are both 6-foot diameter columns, each with 20 half-cross flow bubble cap trays with 24-inch tray spacing. Initial weir height was 2½ inches. This has been raised by means of adjustable weirs to 4 inches for increased retention time. Both columns, and all solution piping in the plant, have been stress relieved to prevent stress corrosion cracking.

Solution circulating pumps are driven by steam turbines. One turbine drives both a booster pump and a main circulation pump. Two units are installed, one operating and one standby. All pump cases and impellers are 316 stainless steel. Exhaust steam from the turbines is used for regeneration of the solution.

Operating data for the 1-C plant under various test conditions are given in Tables 4, 5, and 6.

Operating Problems

Cavitation: When initially placing both of these plants in operation, cavitation in the circulating pumps was encountered to varying degrees. This appeared much more severe at 1-C than at the AP-2 plant. It is believed that the problem was greatly accentuated by inefficient regeneration which resulted in flashing of carbon dioxide in the pump suction. Installation of the booster pump at 1-C has corrected the problem. At AP-2, where better stripping was obtained, the problem was eliminated by addition of a surface active agent to the solution and by lowering the solution concentration.

Corrosion: During initial operations at both plants, 3,000 ppm of chromate was used in the solution as a corrosion inhibitor. In a short time, however, it was noted that the chromate was reacting with the hydrogen sulfide in the gas (0.2 to 0.3 grs./100 scf) and was precipitating as chromic oxide mud. Side stream filters were installed in both plants to remove the insoluble material.

While chromate was still in the system, however, severe corrosion was experienced in spots were turbulence was encountered; in the solution pumps, in the solution control valve out of the contactor and in the adjacent piping, at sample connections, and throughout the system where any leaks occurred. In repairing the pumps, various resistant alloys were used but with very little success. The corrosion problem was aggravated by solid material in the solution, and by inefficient regenerating of the solution. At points where dissimilar metals were in contact, such as at metallic gasket surfaces, corrosion was accelerated. In some instances valves, sections of piping, and some pump parts lasted just a few hours.

Several steps were taken to stop the corrosion failures. (1) 316 stainless steel solution control valve, piping, and bypass valves were installed at the contactor. (2) 316 stainless steel pump case and impellers with hardened stainless wear rings, diaphragm and pump shaft were installed. At 1-C, both original pumps and the

TABLE 3—Typical Daily Operations (AP-2 Plant)

	8-4	8-8	8-29	8-30	9-2
RATES					
Gas To Cont. MCF/D	2,262	3,915	4,437	3,045	4,176
Sol'n. To Cont. GPM	64	82	88	66	64
CO_2 Reject MCF/D (Metered)	160	275	321	160	307
Steam To Reboiler Lbs./Hr.	1,505	3,216	3,135	2,090	3,019
ANALYSIS					
% CO_2 Inlet	7.8	7.8	7.8	7.8	7.8
% CO_2 Outlet	0.4	0.5	0.5	0.5	1.0
FT^3/Gal.	1.73	2.32	2.53	1.69	3.33
FT^3/Lb. of Steam	4.42	3.57	4.27	3.29	4.24
Equiv. % K_2CO_3	21.4	21.7	21.5	20.8	21.3
Rich Sol'n. % Conver.	.....	.....	.....	.....	.....
Lean Sol'n. % Conver.	35.1	30.5	32.9	32.4	35.4
Sp. Gr.	1.190*	1.180*	1.200*	1.180*	1.180*
PRESSURES					
Contactor Base, psig	375	385	390	375	390
Regen. Top Press., psig	1.0	1.5	1.5	1.0	1.5
Regen. Base, psig	6.0	6.0	6.0	6.0	6.0
TEMPERATURES					
Contactor					
Gas To °F.	277	276	278	268	285
Gas Fr. °F.	.....	.....	.....	.....	.....
Liquor To °F.	.....	.....	.....	.....	.....
Liquor Fr. °F.	225	229	228	222	230
Regenerator					
Top °F.	.....	.....	.....	.....	.....
Liquor Fr. °F.	220	225	220	222	218
Reflux	.....	.....	.....	.....	.....

REMARKS
Antifoam agent added for all tests
* At 220 F.

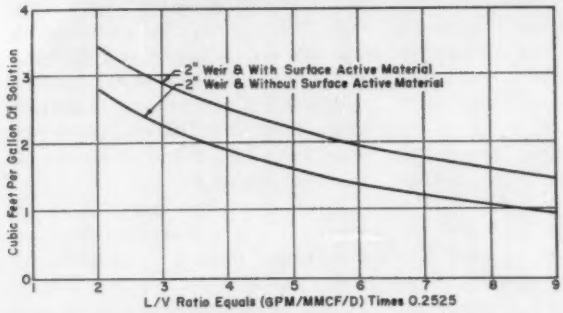
Cubic Feet Per Gallon Of Solution
2" Weir & With Surface Active Material
2" Weir & Without Surface Active Material
L/V Ratio Equals (GPM/MMCF/D) Times 0.2525

FIGURE 3—How surface active material affected overall efficiency at AP-2 plant.

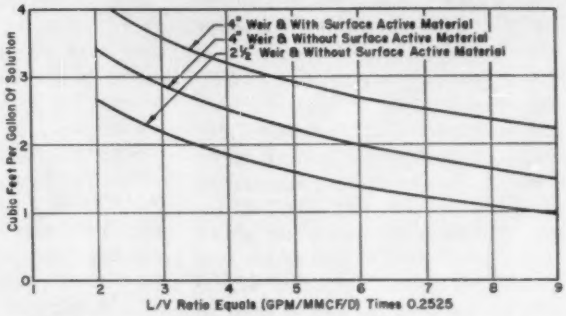
Cubic Feet Per Gallon Of Solution
4" Weir & With Surface Active Material
4" Weir & Without Surface Active Material
2½" Weir & Without Surface Active Material
L/V Ratio Equals (GPM/MMCF/D) Times 0.2525

FIGURE 4—Cubic feet of carbon dioxide per gallon of solution versus L/V ratio at 1-C plant.

temporary booster pump were replaced with stainless steel. At AP-2, one pump was replaced completely with alloy materials. A second pump, for standby service, was not replaced. (3) Where leaks occurred at gasketed surfaces, gaskets were replaced with graphite-asbestos material. (4) At AP-2, continuous injection of chromate solution was initiated to maintain a concentration in excess of 1,000 ppm. At the same time, the solution concentration was reduced and a surface active agent introduced into the system, resulting in an overall increase in efficiency. Combination of these appears to have stopped corrosion. At 1-C, an inhibitor, which does not react with hydrogen sulfide, is continuously injected into the solution to build an excess of 300 ppm of the inhibitor. Modifications were also made to effect increased efficiency.

Both plants have now been operating continuously for several months and corrosion appears to be controlled. Only operation for a long period with frequent inspections will prove the complete effectiveness of the corrosion control program.

Column Stability: During the first test periods of operation, some difficulty was experienced at both plants which indicated unstable operation and hold-up of solution in the process columns. This also resulted in a change in efficiency of operation at these times. It is believed that the surface tension properties of the hot carbonate solution were such that very inefficient contact, between the gas and the solution in the contactor or the steam and solution in the regenerator, was occurring, resulting in a low tray efficiency. The effect apparently was coning, bumping, or jetting through the solution with high entrainment. No evidence of foaming could be found. The high entrainment resulted in intermittent hold-up in the columns.

Addition of surface active agents in both plants have made the operation of the plants much more stable, eliminated the hold-up problem, and resulted in an overall increase in efficiency of extraction. At AP-2, two silicone materials have been tried, both of which were successful. Although these materials are generally classed as anti-foam compounds, the quantities in which they were added appear to have induced some foaming

TABLE 4

Test Data 1-C Plant 2½-Inch Weirs in Both Columns Without Surface Active Materials in Solution

TEST NO.	Design	1	2	3	4	5	6	7	8	9
FLOW RATES										
Gas Fr. Contactor MMCF/D	38.9	15.2	19.2	19.5	19.8	20.7	20.8	20.0	20.6	21.2
Gas Fr. Cont. (Corr. Dry Basis) MMCF/D	37.9	14.3	18.0	18.5	18.7	19.9	19.9	19.2	19.8	20.4
Solution to Contactor GPM	490	537	254	257	246	244	343	236	256	426
Steam to Regenerator #/Hr.	9,228	8,750	4,340	4,310	4,250	4,190	4,460	4,390	4,110	3,960
Steam to Reboiler #/Hr.	9,874	8,730	7,710	10,800	10,900	10,900	11,100	10,700	10,600	11,400
CO_2 to Stack (Calculated*) MCF/D	2,273	1,022	820	789	830	671	786	690	708	911
ANALYSIS DATA										
CO_2 Inlet Gas %	10.1	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.9	10.0
Outlet Gas %	4.6	3.4	5.75	6.0	5.85	6.8	6.3	6.6	6.7	6.0
Equivalent K_2CO_3 Wt. %	28.2	16.8	20.5	19.0	27.2	28.2	27.3	35.8	19.6	18.7
Conversion-Lean Sol'n. %	30.0	43.0	37	38.5	40	45	48	47	43	47
-Rich Sol'n. %	70.6	76.0	79	82.5	71	69	69	66	81	78
PRESSURES										
Contactor Base, psig	400	405	404	406	407	406	403	403	403	403
Regenerator Top, psig	0	11.6	7.9	7.0	7.1	0	0	0	0	0
Base, psig	.....	13.7	9.3	8.8	8.9	2.4	2.55	2.8	3.0	2.9
TEMPERATURES										
Contactor, Gas to °F	200	246	243	206	203	206	207	210	197	195
Gas From °F	201	241	241	228	234	214	218	218	213	214
Sol'n. to °F	200	243	241	238	241	222	226	225	220	216
Sol'n. From °F	204	240	230	217	219	209	214	216	206	211
Regenerator-Sol'n. to °F	.....	238	228	215	218	208	212	217	205	212
Sol'n. From °F	230	248	240	239	242	226	225	228	223	221
Top °F	197	231	210	223	226	211	212	209	212	208
OPERATING RATIOS										
CO_2 to Solution Cu. Ft./Gal.	3.22	1.3	2.2	2.1	2.3	1.9	1.6	2.0	1.9	1.5
CO_2 to Steam Cu. Ft./#	4.78	2.3	2.7	2.2	2.2	1.9	2.1	1.9	2.0	2.5
Contactor Tray Efficiency %	5.0	5.09	4.46	4.22	3.37	2.29	2.66	2.70	2.81	3.00
Regenerator Tray Efficiency %	12.0	7.06	6.60	6.60	5.04	2.39	2.39	1.56	4.81	5.05

* CO_2 Extraction Based on Analyses

in the columns. The foam, however, is very unstable and breaks readily. At 1-C plant, a surface active material is added with the inhibitor and gives comparable results with those obtained at AP-2. Results of tests with and without surface active agents are given in the data tables.

The effect of surface active materials on the overall efficiency is shown graphically in Figures 3 and 4. The L/V ratio is a straight numerical ratio of solution to gas and does not take into account slight differences in solution concentration. It is planned to test other surface active materials which may result in a still higher increase in operating efficiency.

Over-all Extraction Efficiency: Initial test data indicated that the extraction efficiency of the 1-C plant was less than required to meet specification for sales gas. This was attributed to be too low a retention time and insufficient contact between the solution and gas or steam. To correct the low efficiency, adjustable weirs were placed in both columns, and weir height raised from 2½ to 4 inches. As indicated by the test data, this resulted in a big increase in overall efficiency (graphically shown in Figure 4). A test was attempted with weirs set at 5½ inches but capacity of the columns was reduced below operating limits and the test could not be completed.

Tests were also run to determine effect of increased regenerator pressure and resultant higher temperature level in the plant. These data indicate that some increased extraction can be obtained at regenerator pressures of 10 to 15 psig over that obtained when operating at atmospheric pressures.

At AP-2, the over-all extraction efficiency was satisfactory without modification of original facilities.

Plugging Problems: Initial operation of the AP-2 plant was carried

TABLE 5

Test Data 1-C Plant 4-Inch Weirs in Both Columns Surface Active Materials in Solution As Indicated

TEST NO.	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
FLOW RATES																
Gas Fr. Contactor MMCF/D	30.6	32.2	32.5	32.8	32.9	32.6	33.1	32.2	33.5	34.3	43.5	22.4	32.2	32.5	32.4	32.0
Gas Fr. Cont. (Corr. Dry Basis) MMCF/D	28.7	30.2	30.5	30.9	30.8	31.0	31.1	30.4	31.5	32.2	40.9	21.1	30.3	30.5	30.4	30.2
Solution to Contactor GPM	556	556	551	555	565	568	550	556	453	553	551	555	570	544	556	557
Steam to Regenerator #/Hr.	12,580	12,330	12,270	12,190	12,100	12,000	9,200	12,430	12,650	12,100	12,150	12,700	12,430	12,520	12,370	12,280
Steam to Reboiler #/Hr.	8,520	8,050	8,190	8,070	7,960	8,080	6,000	7,860	7,860	7,680	7,570	7,950	7,790	7,550	7,560	7,760
CO_2 to Stack (Calculated*) MCF/D	1,985	1,910	2,110	2,040	1,970	1,880	1,895	2,080	1,830	2,120	2,130	1,910	1,840	2,280	2,100	2,100
ANALYSIS DATA																
CO_2 Inlet Gas %	9.4	9.4	9.6	9.6	9.7	9.5	9.4	9.4	9.6	9.8	9.4	9.45	9.35	9.6	9.6	9.6
Outlet Gas %	3.2	3.7	3.4	3.7	4.0	4.1	3.9	3.2	4.4	3.5	4.7	1.30	3.85	2.9	3.4	3.4
Equivalent K_2CO_3 Wt. %	23.7	22.7	24.1	23.3	21.0	20.0	22.7	23.8	23.8	24.4	24.4	24.2	18.5	27.8	23.7	23.6
Conversion-Lean Sol'n. %	35.8	36.9	35.3	37.0	36.5	40.3	40.1	36.5	33.3	35.5	36.2	33.9	34.8	34.9	35.2	37.0
-Rich Sol'n. %	75.2	76.5	76.1	77.9	80.6	84.1	79.0	77.7	77.7	76.0	76.8	70.5	82.0	72.5	76.8	78.5
PRESSURES																
Contactor Base, psig	409	407	408	409	409	410	415	409	410	412	417	410	412	408	408	410
Regenerator Base, psig	14.9	15.0	15.0	10.2	15.2	4.3	15.2	15.5	15.1	15.0	14.8	14.7	14.8	14.8	15.0	9.7
TEMPERATURES																
Contactor Avg. °F	242	243	243	235	244	223	245	244	243	243	242	246	244	249	247	238
Regenerator Avg. °F	243	238	237	229	238	216	238	241	242	240	230	240	241	241	241	230
OPERATING RATIOS																
CO_2 to Solution Cu. Ft./Gal.	2.5	2.4	2.7	2.6	2.4	2.3	2.4	2.6	2.8	2.7	2.7	2.4	2.2	2.9	2.6	2.5
CO_2 to Steam Cu. Ft./#	3.9	3.8	4.3	4.2	4.1	3.9	5.2	4.3	3.7	4.5	4.5	3.9	3.8	4.7	4.3	4.3
Contactor Tray Efficiency %	7.3	6.8	7.4	6.9	7.5	7.1	7.6	8.2	6.6	7.1	6.1	9.5	7.5	8.3	7.6	7.6
Regenerator Tray Efficiency %	10.8	12.7	15.0	10.2	11.2	5.9	11.9	10.5	11.2	10.4	12.6	10.2	12.7	10.0	10.9	10.0
Inhibitor and Surfactant, ppm	100	100	500	500	500	500	500	500	500	1000+	1000+	1000+	1000+	1000+	1000+	1000+
Silicone anti-foam agent, ppm	None	None	100	100	100	100	100	100	100	200	200	200	200	200	200	200

* CO_2 Extraction Based on Analyses.

TABLE 6—1-C Plant Data 4-Inch Weirs in Both Columns Surface Active Materials As Indicated

TEST NO.	26	27	28	29	30	CURRENT OPERATIONS 6/23	7/21	8/1
FLOW RATES								
Gas Fr. Contactor MMCF/D	21.2	32.9	33.2	32.3	39.3	37.6	37.2	37.4
Gas Fr. Cont. (Corr. Dry Basis) MMCF/D	20.2	30.7	31.0	30.2	36.6	35.2	35.2	35.2
Solution to Contactor GPM	428	549	547	547	547	519	490	470
Steam to Regenerator #/Hr.	3,840	13,410	13,520	13,410	13,650	13,450	10,400	10,730
Steam to Reboiler #/Hr.	11,290	7,440	7,260	7,210	7,160	7,100	7,320	7,180
CO_2 to Stack (Calculated) MCF/D	1,332	1,990	2,220	2,180	2,230	2,240	2,060	1,750
ANALYSIS DATA								
CO_2 Inlet Gas %	9.5	9.3	9.3	9.3	9.25	9.3	9.3	8.9
Outlet Gas %	3.6	3.5	2.9	2.85	3.8	3.9	4.5	4.7
Equivalent K_2CO_3 Wt. %	18.4	28.4	28.3	28.6	28.6	27.8	25.2	22.3
Conversion-Lean Sol'n. %	39.5	36.7	36.7	37.1	37.4	35.6	36.8	37.7
Rich Sol'n. %	85.4	68.4	72.4	71.6	72.8	74.3	79.5	81.6
PRESSURES								
Contactor Base, psig	411	413	410	411	411	410	410	410
Regenerator Base, psig	3.7	15.4	14.8	14.6	15.1	13.3	7.8	7.8
TEMPERATURES								
Contactor Avg. °F	223	249	248	249	246	240	225	227
Regenerator Avg. °F	215	243	241	241	240	246	231	232
OPERATING RATIOS								
CO_2 to Solution Cu. Ft./Gal.	2.17	2.52	2.82	2.78	2.83	3.00	2.93	2.60
CO_2 to Steam Cu. Ft./#	3.70	3.98	4.45	4.40	4.47	4.53	4.86	4.07
Contactor Tray Efficiency %	7.5	6.3	8.5	8.4	7.3	.....	.....	.....
Regenerator Tray Efficiency %	6.8	7.8	8.9	7.9	10.0	.....	.....	.....
Inhibitor and Surfactant ppm	None	None	1000	1000	1000	1500+	1500+	1500+
Silicone anti-foam agent ppm	None	None	None	100	100	None	None	None

out with a 40 Wt. % carbonate solution. At this concentration, repeated difficulty was encountered due to crystals forming in the solution, at times being circulated with the solution and sometimes causing plugging difficulties within the lines, vessels and at the solution control valve out of the contactor. Considerable trouble was also encountered in plugging of instrument lines and sample connections. These problems did not disappear entirely until solution strength was reduced below 28 Wt. %. Similar difficulties were encountered at 1-C plant on test runs at 30 to 35 Wt. %. Solution concentrations are now maintained at both plants below 28 Wt. %.

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Current Operations. Current operating data indicate that both plants are safely meeting required specifications. However, it is felt that the use of surface active materials is required for continuous steady operation. No further difficulties due to corrosion have been encountered. At AP-2, carbon dioxide content of the treated gas is consistently below 1 percent and more generally at about 0.5 percent. This stream is then blended with untreated gas to meet sales gas specifications. At 1-C, the solution rate is varied to maintain specification gas at the dry gas outlet of the hydrocarbon absorption plant.

Under present continuous operations at both plants, carbon dioxide pickup varies from 2.7 to 3.2 cu. ft./gal. of solution circulated. Carbon dioxide rejected at the regenerator is in the range of 3 to 5 cu. ft./# of steam. These capacities are somewhat lower than those reported in the literature, however, continued testing to determine optimum operating conditions may result in higher efficiencies. Operation at lower solution concentrations reduces solution carrying capacity somewhat, although the reduction in capacity has been shown to be very much less than the proportional reduction in concentration due to resultant changes in over-all efficiency.

Present performance of the perforated or bubble cap trays in these plants compares favorably with results obtained in other operating plants which have installed packed columns. Preference of one type of column or tray for future design would be based on economic evaluation.

Intake gases at both plants vary in hydrogen sulfide content from .20 to .30 grs./100 scf. No hydrogen sulfide is now found in the discharge of either carbonate plant. At 1-C, where the acid gas is removed on the plant intake, tests indicate complete removal of hydrogen sulfide from all plant streams. This should result in reduced corrosion rates in the gasoline plant proper.

Plant Control: Carbon dioxide analyzing and recording instruments, installed on sales gas outlets from both plants, provide a continuous check on plant operations. Control of solution concentration by plant operators is satisfactorily done by checking specific gravity with a hydrometer at a fixed temperature.

Complete plant tests are run by laboratory personnel as required. All control analyses are conducted by standard methods of analysis.[4] Solution samples must be taken under pressure to prevent flashing of carbon dioxide prior to the analysis.

Performance of these two plants has proved the industrial application of the hot potassium carbonate process for removal of carbon dioxide from natural gas. In these cases, use of this process rather than the amine plant, resulted in: (1) lower construction cost, (2) considerably lower heating and cooling requirements, and (3) negligible chemical usage. Presence of approximately 0.3 percent oxygen in the intake gas has not been troublesome, whereas, oxygen in an amine plant usually results in severe corrosion problems.

These plants have completely removed the small amount of hydrogen sulfide present in the intake gases. It is believed that this process can be successfully employed for removal of much larger amounts of H_2S to meet present salesgas specifications.

It is also believed that this process is applicable for removal of carbon dioxide at a much lower partial pressure than has previously been indicated in the literature. Multi-stage contact of the gas with solutions of optimum concentrations, will result in a very high purity of the treated gas.

Performance of the hot potassium carbonate plants now in operation, and savings realized in construction and operating costs, should result in an increasing preference for this process where applicable over those previously used in removal of acid gases.

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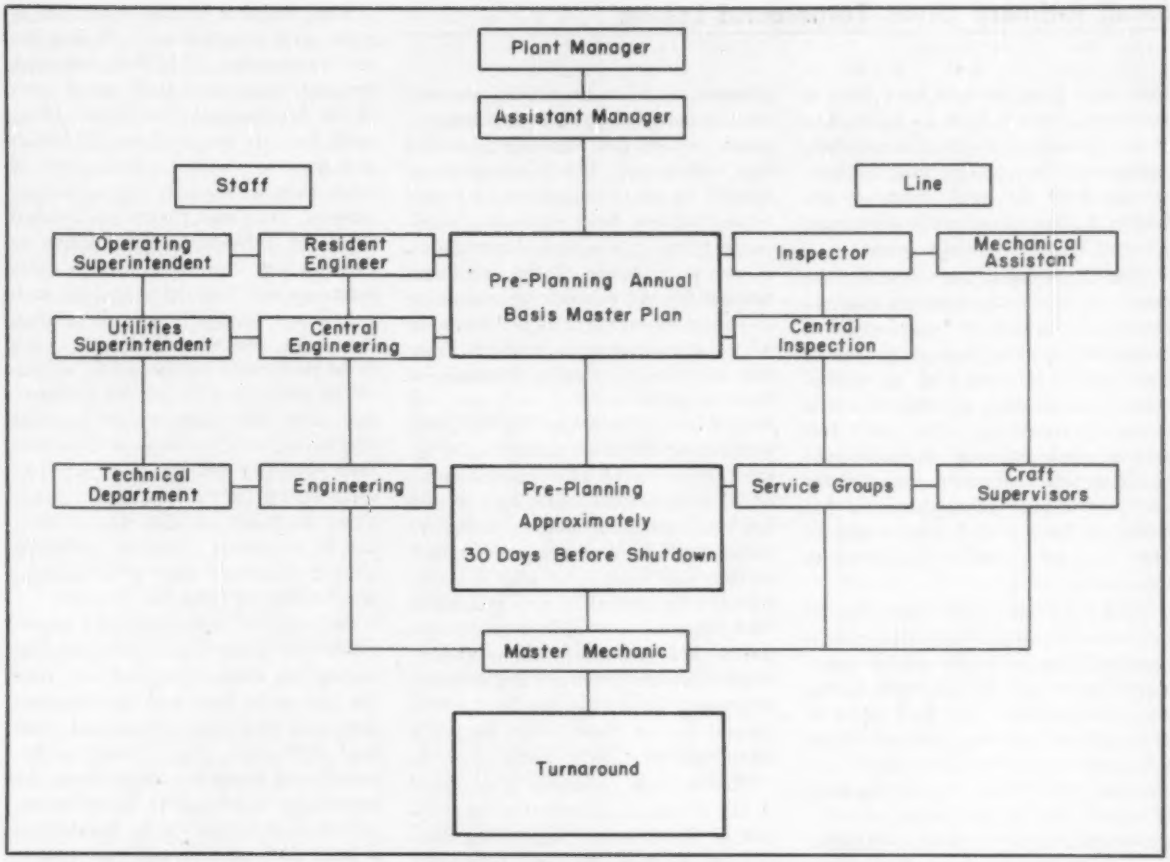

FIGURE 1—Preplanning is carried out by entire staff the year around and starts with a meeting following a turnaround.

Small Refinery Gives Turnaround Lesson

Sinclair's Wyoming refinery learned that group effort works better than a planning staff when preparing for a turnaround

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MAINTENANCE TURNAROUND PLANNING at Sinclair, Wyo., consists of a group effort without the aid of a specific planning staff. This system is the result of 15 years of trial-and-error methods dedicated to fast, efficient turnarounds through joint responsibility.

At first glance, a large refinery manager would probably shudder at the thought of such a system. But the small refinery manager knows that planning economy must be achieved by getting the most from personnel available. This has been the situation at our Sinclair, Wyoming, refinery and it is our opinion that the system is both efficient and practical.

Turnaround maintenance at this refinery consists of repairs to a 10,000-bpd fluid catalytic cracking unit, its stabilization and alkylation units, two 100,000 pounds per hr., 600 psi boilers, auxiliary water treating facilities, and all electrical facilities that can be attended. These units were all built in 1943 as part of a World War II

expansion program and have been in continuous operation 15 years. The shutting down of these units cuts daily production by approximately half, consequently the stock inventory before and after turnarounds is seriously affected by all off-stream hours.

The above units are scheduled for repair once a year, with an approximate allowance of two weeks of downtime to effect repairs and all of these units are repaired simultaneously. Actual date of shutdown is tentative, contingent upon such factors as stock situation, material supply, manpower situation, etc., but for the past several years this date has been set for the first two weeks of May, and all planning is directed to this date.

Planning is affected considerably by the refinery location, which is approximately 250 miles to the nearest major supply point and an available skilled manpower market. This fact forces us to maintain our own supplies and equipment as well as do the work with our own plant force. Specialties such as regenerator lining or repair of electric generating facilities are contracted to specialty contractors when necessary but our planning "keynotes" the use of our own maintenance force. We do supplement our force from a limited local labor market but this is temporary help of unskilled nature. Skilled crafts are all obtained from our regular plant forces. Our average mechanical force available for turnaround work, excluding supervisors and service forces is approximately 120 Mechanical department employes subdivided to approximately 71 men at the fluid unit, 27 at the alkylation plant and 22 at the boiler and power house.

Mechanics of our planning are handled as a joint operation with management directing all supporting departments in a combined effort as shown in Figure 1.

Turnaround Planning. Our turnaround planning is a year around project which progresses daily until the turnaround is complete, but for purposes of this article it is subdivided into three stages: pre-preplanning, preplanning and shutdown.

Pre-preplanning or the initial stage, consists of a management meeting held as soon as inspection and maintenance reports are available from the last turnaround. This meeting is attended by plant managers and staff representatives from operating, engineering and mechanical departments. A review is made of the last turnaround for the purpose of evaluating the general mechanical condition of all the operating units involved. From this review an attempt is made to forecast which parts of each unit will require major attention for the next turnaround or future turnarounds. Inspection reports and recommendations, known wear rates, line section analysis, operation studies, foremen's recommendations all are given consideration and a tentative plan is established. This plan then acts as a guide for further study by individual departments. This procedure allows considerable time for extensive engineering, operation, inspection studies and in general allows plant forces to get a good head start on turnaround work.

Considerable assistance is available to our planning through the cooperation of the Central Engineering division of Sinclair Refining Company. This group has a wide range of knowledge and experience of turnaround problems at all Sinclair refineries. They are available for consultation during all stages of our planning and when concerned with special problems attend our planning meetings and follow major projects through actual turnaround. Their recommendations and on the job assistance have proved very valuable.

From this point until the start of our second stage planning, notes are kept regarding all items which will require attention during turnaround. This information is logged by unit foremen but is also disbursed daily to the mechanical department by discussion at operational meetings held every morning. The resident engineer attends this meeting and in turn alerts the mechanical department of work at these units which will have to be done during turnaround or that can be done while the units are on stream. Information from this source alerts our maintenance forces of work that can be completed months ahead and forms a skeleton outline for preplanning turnaround.

This skeleton outline continues to grow until approximately 30 days before turnaround. It is then reviewed, brought up-to-date and turned over to the Mechanical department. Here, work lists are prepared for each unit and then subdivided into sections of units such as reactor, regenerator, blowers, etc., and then subdivided again to individual jobs relative to each section. These work lists are quite extensive and detailed to include such points as—Safety Notes, Blinding Schedules, Manway Schedules, work to be performed by operators, technical personnel and individual mechanical crafts, what materials are required and where they are located, reference to drawings, sketches, reports, etc. The work list for the 1957 catalytic cracker alone consisted of 250 major items and 83 sub-items. All other operating units concerned during turnaround are handled in the same manner.

Individual operating unit supervisors play a big roll in our planning during this stage. They not only note the jobs to be done but they evaluate them and notify maintenance of practical difficulties, etc. Their understanding of operation allows them the knowledge of what is or is not important or that which can be handled at a later date and should not receive unwarranted attention. Many years of actual turnaround experience are required before enough knowledge is gained to be able to render sound decisions in many of these cases.

Preplanning. At this plant, our prepreplanning is complete, the master plan has been consolidated, and preplanning begins. A meeting of all supervisory personnel connected with shutdown is held and persons attending are as follows: Plant Manager and Assistant, Operations Representatives, Technical Assistants, Resident Engineer, Master Mechanic, Inspectors, Personnel Manager, Craft Supervisors and interested parties from the Central Engineering Division of Sinclair Refining Company.

At this meeting the entire group of work lists is reviewed, assignments made and questions answered. Each interested party receives a copy of the work lists and it becomes his responsibility to get as much work as possible completed or ready for shutdown. Joint responsibility still prevails at this point but the entire program of actual work comes under the jurisdiction of the resident engineer and master me-

chanic who coordinate staff and line functions and generally keep the ball rolling toward turnaround.

The close harmony that exists as we get ready for turnaround is the result of many years of experience. In fact, we do not have a line supervisor with less than 10 years of turnaround experience. This is of great value to preplanning and to actually doing the job.

Nevertheless the following steps must all be given consideration:

Manpower. Mechanical forces are enlarged by reducing operating manpower to a bare minimum and transferring these men to mechanical labor; setting up student mechanics to Class A mechanics, and assigning all mechanical employes possible to turnaround work.

In addition, no leaves of absence are granted and no vacations are allowed two weeks before, during, and two weeks after the scheduled shutdown.

Mechanical Equipment. All equipment and tools are repaired, placed in first class operating condition and moved to the units before shutdown. Every effort is made to locate this equipment in the immediate vicinity where it will start work.

Rigging equipment is set and rigged, and scaffolding is distributed to the various locations and floors for easy access. Welding machines, hoists, and tools of all types are distributed to the units concerned several weeks before actual shutdown. Consequently, they must be conveniently located but must not interfere with still operation. This requires detailed planning by craft supervisors with knowledge gained from previous turnarounds.

Operating-Equipment Replacements. Equipment such as exchanger bundles, slide valves, large valves, piping sections, etc., are installed as whole units whenever feasible. To do this, we carry spare units for all items that have high wear rates or other operating problems. This equipment is used every other year and rather than try to effect repairs during a shutdown, we replace them if manhours can be saved. The displaced equipment is then reconditioned between turnarounds as fill-in work. We have been able to standardize this work to a high degree, even to the extent of assigning the same craftsmen to make the same replacements each turnaround. By doing this, the craftsmen are familiar with the problems of replacing these units and are able to achieve fast and correct installations. This avoids the time consuming proposition of assigning new men to new work which invites longer handling time and the possibility of incorrect installation.

When a replacement unit is reconditioned and ready for service, we make it a part of the job to transport it to the exact site on the operating unit where it will be used or to the immediate vicinity whenever possible.

Replacement Materials. Valves, fittings, pipe, wear pads, plates, all are brought to the job site and stored on the units as close as possible to known use. Sizes and types are scheduled and it is a craft supervisor's responsibility to have the materials required at the job site before shutdown. We make every effort to have all materials on the job to avoid holdups. Even to the extent of having too much on the job and having to return it after the shutdown.

In connection with material supply, our catalytic cracker has one combination freight and passenger elevator to cover eight floors of a 13-floor unit. Consequently, all movements that can be made before shutdown are made to prevent bottlenecks during shutdown.

Approximately a week before actual shutdown, a final pre-planning meeting is held to check all items on the work lists. At this meeting all items are discussed in the sequence in which the work will be performed. Coordination is the keynote and everything is pointed to this goal. Work bottlenecks, time tables, craft problems, hours of work and feeding problems of crafts working overtime, are all lined out and at the end of the meeting supervisors are ready for turnaround.

Shutdown. In order to get turnaround off to a good start we schedule the units to start down over a week-end; then, we bring out a limited number of pipefitters on Sunday to start blinding and opening vessels. This allows a large part of our task force to go right to work Monday morning, as parts of the units will be cool enough to work on. In addition, we change our work day from 8 to 9 hours and include Saturdays and Sundays on bottleneck jobs during the turnaround.

At this point we are ready and enter the final stage of turnaround of the units. Here joint responsibility ends and all effort is under the direct control of the master mechanic. Daily planning meetings are held each afternoon at the fluid unit to plan the following day's work. At this meeting preplanning schedules are checked and adjustments for additional work or deviation from schedule are handled on individual project merit. This generally calls for revamping craft schedules such as additional overtime or shift work. It has been our experience that our thinking during this period must be very flexible because it would be difficult to count the number of times we thought we would encounter trouble at a particular point only to find it required minimum attention, and vice versa.

Timing and coordination are the big planning problems during the actual shutdown and an extensive effort has been made to ease this problem as much as possible through communication systems. We have loud speaking equipment, portable hand radios, radios in trucks, telephone horn blowing code systems and telephones strategically located on the units with direct lines to the storehouse.

All of these facilities are directed from the main control room at the fluid unit. This is considered headquarters for the master mechanic and all directives, changes of plan, or manpower or material problems pass directly through this supervision.

Our actual turnaround work has become standardized to the point of being routine. We believe this to be a very valuable asset in effectively planning a turnaround and in executing the plan. One of the prime values of this lies in the fact that the master mechanic is free of minor job decisions and can devote his thinking to over-all coordination.

Turnaround Planning Benefits. The true value of turnaround maintenance planning cannot be determined by statistical comparison of turnaround to turnaround or plant to plant, because of the everchanging situation each year. The only tangible value that can be attributed to planning must be measured by the length of time the unit is down in relation to schedule.

During the early years of turnarounds at Sinclair, Wyoming, it was

Small Refinery Gives Turnaround Lesson . . .

About the Author

G. M. Allen is an engineer for Sinclair Refining Co., Sinclair, Wyo., where he coordinates planning and scheduling in conjunction with both the Maintenance and Engineering departments. A former student of mechanical engineering at the University of Wyoming, Allen has six years' experience in general engineering, five years in plant maintenance, and 11 years in various phases of "turnaround".

not unusual to have turnarounds two or three times a year with little or no assurance that the unit wouldn't fail between turnarounds. With the advent of turnaround maintenance planning, we have reasonable assurance that we can operate continuously for a year without a loss of stream hours. This fact alone provides a definite payoff by allowing a tight schedule of plant operation without upsets.

There are also many tangible benefits that can only be observed and evaluated through local experience, but these benefits are definite and real money makers developed as a by-product of planning.

Some of these benefits are as follows:

1. Close cooperation between operating and mechanical departments. As this program progresses continuously throughout the year it is absolutely necessary to have harmony between departments because of our limited available manpower. This not only applies to units involved in turnaround, but all units. The other units are aware that they must be cared for between turnarounds, and look to the future accordingly.

A second value received here lies in the fact that no one person is critical to planning and executing a turnaround. Everyone is familiar with individual department function and planning, and in the event of absenteeism, transfer, illness, etc., the planning procedure is not reduced or affected in any way. The overlap of department responsibility tends to broaden department knowledge of each other's function. This allows consideration for the practical or applied aspects of each department.

2. The same spirit of teamwork that exists with inter-departments carries to craft supervisors and craftsmen. By having the information of what is expected during a turnaround, all departments have their individual planning complete and ready to go at shutdown. This tends to make everyone aware that they play a very important part in turnarounds and success hinges on their fulfilling their assigned projects. This medium of orderly thinking prevents confusion or lack of coordination on the job and allows crafts to spend their full working day doing the job.

3. Preplanning eases the problems of material and equipment supply by offering considerable time to overcome bottlenecks and allowing time to consider the many aspects of substitution. Our location is such, that if we didn't have materials or equipment on hand to do the job, our downtime could be extended for lack of even minor items.

4. With any form of planning, a large amount of historical data accumulates and this is true of our turnaround planning. From this data, we have been able to establish definite trends or consistencies relative to each unit of our turnaround effort. This in turn allows us to develop our manpower requirements for a given period of shutdown and distribute them to the various operating units as required. The insight acquired through accumulated data is a great aid to flexible thinking necessary for planning turnarounds.

Some of the percentages which have become known to us through accumulated historical data are summarized in Table 1.

5. A silent benefit that we don't hear much about but which makes itself known by its record, is safety. Both the safety and inspection departments have a complete knowledge of the over-all plans and are in a position to recommend safe ways and means to do a job.

Our safety department states that the practice of safety during turnarounds is the best effort of the year. The record speaks for itself when we say the last lost time accident to happen during shutdown occurred four years ago.

These are but a few of the benefits that we attribute to our preplanning maintenance turnarounds. It is our opinion that less supervision is required, service forces stay on schedule, crafts do better work, more work is done each year without additional downtime, etc.

Our planning system is not perfect in any sense of the word, but it is economical and has provided comparable and effective turnarounds. We recommend this system to all small plants that have men of experience ready and able to give just a little extra effort to get the job done right.

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TABLE 1.—High and low percentages developed from turnaround data

CRAFT REQUIREMENTS: Percent of Work Performed by Craft Of Total Manhours Required by Unit	CATALYTIC CRACKING UNIT		ALKYLATION UNIT		BOILER AND POWER FACILITIES	
	High	Low	High	Low	High	Low
Welders and Boilermakers	29	25	6	5	13	10
Machinists and Mechanics	16	13	18	12	36	27
Pipefitters	26	22	59	52	22	18
Insulators	4	2	6	3	9	2
Riggers	12	7	14	6	5	1
Bricklayers	4	2	1	0	7	3
Electricians	3	3	1	0	2	1
Carpenters	9	6	4	3	1	1
Assigned Cranes, Trucks, Tractor Operators	3	3	1	1	1	1
Labor	8	5	10	3	27	19
Percent of Premium Pay Hours of Total Manhours Required:	31	27	24	17	33	25
Average No. of men per day used:	78	71	31	27	23	20
Percent of Total Mechanical Hourly Force:	45	38	17	16	13	11
No. of Days Required Shutdown	15	10	15	10	10	10

Which Alloy for High Temp. Processes?

Two light hydrocarbon cracking heaters serve as the basis for a study of alloys in the very high temperature range of 1,500-1,800 F.

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New York City

OF THE PLANT operations conducted at truly high temperatures, the two which require alloys of greater heat resistance than available in the extensively used straight chromium grades are the thermal cracking of hydrocarbons to form ethylene and the preparation of hydrogen or of feed gas for ammonia synthesis by steam-methane reforming.

HIGH TEMPERATURE PROCESS

The Ethylene Heater. Of two popular methods, the more widely employed by far, and of special interest here for its material problems, is one utilizing an externally fired tubular coil[1,2] in which a suitable feed stock is thermally cracked to yield ethylene and a mixture of hydrogen and other hydrocarbons. The coil or heater is enclosed in a fire box and consists of straight runs of tubing approximately 4-6 inch diameter and 20-40 feet in length, each connected to its neighbor by fairly close radius return bends and maintained in a horizontal position by refractory or alloy supports. The feed, usually ethane, propane, or fairly pure mixtures of the two, at a pressure of 30-40 psi, is first preheated in the convection section and then passes through the radiant section where it is raised to the reaction temperature and finally outlets into a quench pot. Depending upon its make-up, the feed enters the radiant section usually in the range of 1150-1350 F. and exits at an outlet temperature in the range of 1500-1575 F. Since the residence time must be kept low, a certain amount of steam is employed as a diluent in order to achieve a high

What's Required of Tubes Operating Between 1500-1800 F.

Material. The iron-nickel-chromium compositions potentially capable of resisting the maximum temperature effects likely to be encountered have been considered and interest is centered on the properties of wrought and cast alloys in the composition bracket of 15-25 chromium and 10-35 nickel. Compositions lower in nickel, such as the high-chromium steels, are eliminated for reasons of low strength and embrittlement tendencies, while those higher in nickel are rejected for reasons of cost and susceptibility to certain forms of high temperature attack.

Physical Properties. Among the physical properties desirable in furnace tube alloys, a low expansion coefficient is, of course, useful, but by far the most important is the structural stability, specifically in terms of freedom from embrittlement by sigma phase formation.

Mechanical Properties. The characteristics of these two applications suggest that criterion for tube design should be rupture rather than creep. When three wrought austenitic compositions (Types 309, 310, and 34 Ni/21 Cr alloy) are compared in essentially the same metallurgical condition, the rupture properties are relatively comparable, with some slight superiority in the higher nickel analysis.

Grain Size. The grain size of these wrought compositions has a very profound effect upon the high temperature strength—greater in fact, than differences in alloy composition. The practicality of securing the benefits of a coarse grain size by a special annealing treatment at an unusually high temperature is somewhat tempered by problems of handling in the shop or mill. An apparently successful compromise in grain size and production cost is obtainable in an as-extruded product, in this case, 34 Ni/21 Cr alloy.

Castings. Where operating stresses are high, as in large diameter tubes used in the currently popular methane reforming for NH_3 synthesis, the low hot strength of wrought alloys as a class becomes a serious handicap. One must then consider castings for their substantially better strength, despite the fact that this choice may introduce possible deficiencies in such properties as soundness, rupture ductility, and weldability.

Chemical Properties. Alloys used in methane reforming and ethylene pyrolysis applications may encounter environmental or corrosion effects associated either with the method of operation or from extraneous factors, such as the quality of the fuel employed. Carburization, sulfur attack, and corrosion by incompletely removed welding slag or by vanadium-containing combustion products from certain residual oil are possibilities.

Catalytic Effects. Coke formation, ascribed to the catalytic activity of the particular tube alloy composition used in ethylene pyrolysis, appears to be a fairly remote possibility and one probably depending more upon the particular operating conditions than upon relatively small differences in alloy chemistry.

mass velocity. Consequently, the heat input rate is high (15-20,000 BTU per hour per square foot) and the maximum tube temperature runs appreciably above that of the hydrocarbon stream, perhaps as much as 200 F. for heavy firing. Carbon as a solid reaction product in the form of a hard chemical coke may build up within the coil sooner or later, depending upon operating variables. The presence of more than a small amount of coke is objectable since it interferes with the efficiency of the process and necessitates removal by a decoking operation. The most commonly practiced procedure involves a carefully adjusted combustion of the coke deposits with steam-air mixtures.

A second method of ethylene production that has been increasing in popularity involves the vapor phase cracking of heavy naphtha or gas-oil with superheated steam.[3] In this process, the hydrocarbon feed is preheated in a furnace coil to about 1100-1250 F. and is then combined with steam that has been superheated to about 1700 F. Cracking takes place during a very short residence period as the mixture moves through an unfired transfer line, the steam supplying the necessary heat for cracking in addition to lowering the partial pressure. Preparation of the feed and the stream requires tubular heaters, and the choice of alloy for these units involves mainly considerations of strength and resistance to high temperature corrosion. The transfer line is not fired but, on the other hand, contains the products of cracking at the maximum temperature, and since the feed in most cases is composed of heavy impure hydrocarbons, the principal material problem is attack by sulfur and, to a lesser extent, by carburization.

Steam-Methane Reforming. This operation involves reaction between a hydrocarbon, typically, but not necessarily, methane in the form of natural gas, and steam to yield hydrogen and carbon monoxide. Although either one or the other may be the desired product, the process is more often employed as a source of hydrogen, usually for hydrogenations, and especially for one of the component gases employed in the synthesis of anhydrous ammonia. The reforming reaction is conducted in vertically suspended tubes, ranging in size from about 3-inch to about 10-inch O.D. and about 30 feet in length, which are filled with an appropriate catalyst, usually ceramic-supported nickel, and externally heated to produce temperatures of 1400-1800 F. in the feed gas moving downward through the bed.

Reforming was originally conducted at low pressures on the order of about 30 psig, and under these conditions the main function of the alloy tube was essentially as a metallic envelope for containing the catalyst and reacting gases. Within recent years, where the process has endeavored to keep pace with the increasing demands for anhydrous ammonia, there has been a trend toward high-pressure reforming at inlet pressures of 50 psig or higher. This increase in pressure, although requiring a simultaneous increase in temperature to achieve the same degree of reaction, is very attractive since, as shown by Eichmeyer and Marshall,[4] it accomplishes a highly desirable reduction in the power required to compress the synthesis gas mixtures for conversion to ammonia.

The heat-resisting alloy problems in gas reforming are primarily those associated with specific capability to exhibit useful resistance to relatively high internal gas pressures and high temperatures. Of secondary importance are the effects of various fuels, the reaction feed stocks, and the ability of different alloys to be fabricated.

Materials. From the alloy spectrum of heat and corrosion resisting grades that are produced commercially in the form of pipe or tubing, the basic requirements of ability to withstand for long periods and to display useful engineering properties at metal temperatures ranging upward from 1,500 F. effectively narrow the field of alloy compositions available for comparison. In view of the magnitude of the temperature requirement, as well as other relevant factors, it is felt that the alloy range of interest to this discussion can be defined as a composition area having chromium limits of 15-25 percent and nickel limits of 10-35 percent, with iron and miscellaneous minor elements as the remainder. This area excludes some of the nickel-free chromium steels which, being ferritic, have low strengths and marked tendency to embrittlement. The area also excludes the higher nickel alloys, such as 60 Ni/15 Cr, 78 Ni/15 Cr, and 80 Ni/20 Cr, which are relatively more expensive than the lower nickel alloys and, on occasion, are susceptible to serious damage from the corrosive action of various environments.

Wrought and cast alloys in the above composition range generally have high-nickel and low-chromium contents or vice versa. It is to be noted that the minimum nickel level and nearly the minimum chromium level are combined in the well-known 18/8-base compositions and, as the result, the individuals in this group, despite most useful properties at lower temperatures, are considered underalloyed in terms of strength and resistance to oxidation at temperatures much above 1550 F.

Physical Properties. The first of these is the expansivity or the coefficient of expansion and its dependency upon the temperature. This property is of some importance in processes employing long lengths of tubing along which there exists a temperature gradient. The chief concern under such conditions is that the thermal expansion is not constrained during heating nor the normal thermal contraction hindered during cooling. As a practical reflection, most operators of high temperature units appreciate that startup and shutdown are periods when metal components are more often likely to fail than during normal operation. The problem, of course, is minimized in vertically suspended reforming furnace tubes as compared with the horizontal hairpins in an ethylene cracking coil. Furthermore, in the latter case, the horizontal sections are fastened to cast return bends so that if a temperature difference between adjacent legs exists, a change in length by altering the radius of the heavy return bend is virtually impossible. Fortunately, temperature differences between adjacent tubes are not generally great during normal operation and the necessary change in length is accommodated either by a plastic extension of the tube or, as is more often the case, by a deflection of the entire hairpin away from the tube supports.

The ideal heat-resisting alloy would have a zero coefficient of expansion indicating no change in length re-

gardless of thermal experience. The maximum difference between the austenitic and high-nickel grades is not much more than 10 percent; however, even within this expansivity range may lie the difference between distortion, on the one hand, and actual rupture, on the other.

The second physical property that is of an importance even greater than that of the thermal expansivity is the structural stability of the alloy. By this is meant stability of the particular composition under conditions of prolonged and variable heating with respect to phase changes that could detract either from the originally anticipated mechanical properties or corrosion behavior. Such deterioration in properties with time is particularly troublesome since its occurrence may at first be entirely unexpected by the furnace operator until he is abruptly confronted with devastating failure.

Sigma Phase. The structural change that is of most serious consequence in alloys employed in pyrolysis and methane reforming furnaces is the embrittling effect accompanying the formation of the sigma phase, a hard and brittle complex intermetallic compound, basically iron-chromium, which precipitates from structures that are either ferritic, mixed ferrite and austenite, or marginally austenitic. The sigma phase, depending upon other factors, may occur as isolated pools, usually in sites originally occupied by ferrite, and in this form the embrittling action may be quite mild. In other compositions, the tendency is to form a semicontinuous network of needles at the grain boundaries which may produce a very sharp reduction in ductility and impact strength. Inspection of a number of service failures that have so originated has suggested that sigma in an intergranular pattern may, in addition, produce a marked sensitivity to cracking by cyclic temperature change or thermal fatigue.

The temperature range favoring the precipitation of this phase in susceptible 300-Series stainless steels extends from a rather unusual minimum temperature of about 1100 F. to a maximum of about 1600 F., with embrittlement seeming to occur most readily in annealed alloys at temperatures of 1450-1500 F.

A great deal has been written on the subject of sigma, and numerous

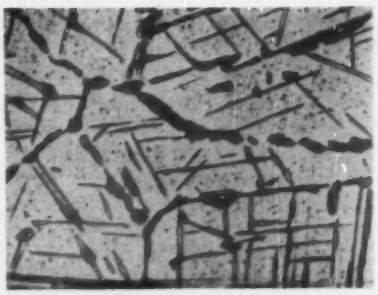

FIGURE 1—This is what sigma formation looks like in a 314 tube that failed between 1300-1400 F.

references exist in literature which discuss details of its formation,[5] the influence of alloy composition,[6] and the resulting effect upon the properties.[7,8] As far as the tendency for sigma to form in engineering alloys is concerned, it is practically impossible to do more than generalize, since within the typical composition limits of several common heat-resisting steels may reside either complete immunity or marked susceptibility to sigma formation. However, since the main requirement for sigma formation is either ferrite or a marginally stable austenite, the relative amounts of ferrite-stabilizing elements as opposed to austenite-stabilizing elements in a given composition may suggest its probable behavior.

The formation of sigma tends to be promoted by chromium, silicon, molybdenum, titanium, niobium, and aluminum, which are ferrite-formers, and tends to be suppressed by carbon, nitrogen, nickel, and manganese, which are austenite-formers. Sigma formation has been reported in all of the 18/8 analyses (with the exception of the high-carbon Type 302) as well as in Types 309, 310, 314, 329, and 446 among the wrought steels. The last two named are ferritic and show a very pronounced tendency to form sigma. Equivalent cast compositions are at least potentially capable of forming sigma, but from a practical standpoint, whether embrittlement will result frequently depends upon the balance between silicon and carbon, both usually high for foundry reasons. It is significant that the wrought alloys containing 25-30 percent nickel or more are immune and may be heated indefinitely within the critical temperature range without fear of sigma embrittlement.

Failure In Sigma Phase. An interesting example of a failure due to sigma formation has been encountered in an 8½-inch I.D. x ¼-inch wall steam-methane reforming tube which was fabricated from Type 314 stainless steel, an analysis similar to the Type 310 (25 Cr/20 Ni) but containing about 2.5 percent silicon, primarily for prevention of carburization. After approximately six months' service, the tube cracked and a large piece broke away reflecting extreme embrittlement, not in the central portion where the metal temperature was about 1800 F., but significantly in a location where the tube extended from the fire box and where the temperature presumably may have been from 1300-1400 F. The fracture was coarsely crystalline, the cold bend ductility and impact strength virtually zero, and the extent of sigma formation within the structure may be seen in Figure 1. While this failure occurred in an alloy composition rather notorious for its embrittlement tendencies, there have been similar experiences with Type 310 stainless steel reforming tubes where cracking has occurred either in the roof section or at the bottom of the fire box where the temperature conditions were favorable. Although mainly a problem in reforming units, it is understood that sigma embrittlement has occurred in pyrolysis furnace tubes (where a cast high-chromium ferritic alloy similar to Type 329 (25 Cr/3 Ni) has been used).

The formation of sigma in an alloy structure is by no means synonymous with failure but is simply indicative of impaired ductility, impact strength, and probably thermal fatigue resistance, with cracking as a probable consequence in the event that any of these properties should be required. The troublesome phase can be dissolved and the metal temporarily restored to its original satisfactory properties by a heat treatment at a minimum temperature of about 1900 F. followed by rapid cooling. The welding repair of a sigma-embrittled structure is impossible unless this heat treatment is first applied.

Mechanical Properties. Into this category fall the properties of the alloy which are concerned with strength in all of its various forms and also with that property which roughly corresponds to the reciprocal of the

strength—the ductility.

As is well known, the main interpretations of high temperature strength relate the initially applied load either to a specific rate of plastic flow or *creep* or to the time to produce actual failure by *rupture*. The creep strength at a particular temperature is the stress that will produce a uniform rate of extension of, say, 0.1 percent/1,000 hours or 0.01 percent/1,000 hours, and data of this type are vitally important in such uses as those involving moving parts where minimum clearances must be maintained. On the other hand, most furnace tube applications can tolerate fairly large amounts of plastic movement or creep without interfering with successful operation, and properties of greater practical importance are, therefore, the time at which failure will occur and the amount of ductility available for the rupture process. It should be said that the strength characteristics in creep and in rupture are not uniquely related and it is dangerous to assume that a high resistance to creep denotes an enduring resistance to rupture or vice versa. It is far better to take both types of strength into consideration, although it is usually permissable for the design to favor one or the other depending upon the application and the consequences of unforeseen failure.[9]

In a general comparison of strength at the higher temperatures, the load-carrying ability of heat-resistant castings is appreciably superior to that of wrought alloys, even those of corresponding base composition. The advantage is so pronounced that for life in excess of 1,000 hours at temperatures of 1800 F. and above, some of the Fe-Ni-Cr *cast* compositions that have been available to industry for more than a generation exhibit comparable or even better strength than obtainable in the best of the complex *wrought* superalloys currently employed for jet engine turbine buckets. The obvious reason for this apparent anomaly is that any wrought alloy, almost by definition, is so constituted that at a sufficiently elevated temperature, it must lose strength and gain ductility in order to be amenable to forming by any of a number of hot working processes. A casting does not have this requirement and, thus, the minor elements in the composition may be adjusted to provide for maximum strength without the necessity of hot formability. It should therefore be appreciated that despite such shortcomings as unsoundness, low ductility, thermal shock sensitivity or impaired weldability that cast compositions occasionally exhibit, they nevertheless represent the preferred form if the operating stresses are high.

Grain Size. Probably one of the most important variables for its influence on the high temperature strength is the grain size. While the effect is less pronounced in cast compositions, it appears to be almost a basic metallurgical characteristic in the behavior of a large number of wrought metals and alloys that within a certain temperature range, a coarse grain size is much stronger than a fine grain size. Considering the wrought heat-resisting grades that are the subject of this discussion, the temperature range where a large grain size is useful would probably extend from about 1,000-1,350 F. (depending on the alloy) to an upper limit of 1800-1900 F., or beyond which the fine grain size cannot be maintained. In this range, the benefit of a large grain size to the creep and rupture strengths would probably be greatest near 1500-1600 F. and, therefore, of great practical importance in furnace tube applications.

Normal mill annealing practice, where applied to a hot- or cold-worked product, usually selects a temperature and time that will yield a fairly uniform, small to medium grain size. Special annealing procedures to obtain large grains involve heat treatment at temperatures of 2,050-2,150 F. for relatively long times and with the cooling often rapid, as by water quenching.

From the practical point of view, the application of this treatment is often an unpleasant operation in the mill or heat treating shop since it is necessary to handle long lengths of tubing in a rapid cool from a very high temperature without producing severe distortion or bending, which would require extensive cold straightening. Creep tests with a high nickel alloy (78 Ni/15 Cr) have suggested that one or two or perhaps up to about 5 percent permanent elongation at room temperature is not harmful to the high temperature properties of the grain-coarsened alloy; however, 10 percent strain is clearly sufficient to cause recrystallization of the large grain pattern to a fine size with corresponding reduction in strength. Therefore, whenever the conditions of service are such that the design must place heavy reliance upon the strength benefit obtained through heat treatment, it should be fully understood that any fabrication or installation procedures that induce more than a small amount of plastic strain or deformation will surely cause a sharp reduction in strength at temperatures in the range of approximately 1,300-1,800 F.

Seamless Tubes of wrought heat-resisting alloys are produced either by the piercing of a billet at high temperatures followed by cold drawing of the resulting shell, or by extrusion at high temperatures to form a tube that need not entail subsequent cold working to yield a usable product. In the latter method, it is possible to convert a solid cast or forged cylindrical billet into a hot finished tube in the single fast operation of extrusion. The newly formed tube emerges from the die at a very high temperature and under conditions that are favorable for the development of a fairly large grain size, although normally one not quite so large as in the alloy that has been deliberately heat treated for a long period at 2050-2150 F. It has now been established for two high nickel alloys (78 Ni/15 Cr and 34 Ni/21 Cr) that the strength of the as-extruded product, especially after a straightening operation by the Medart process, is probably within 80 percent of the maximum obtainable by intentional heat treatment. As the result, certain tubular applications, notably in ethylene heaters where the absolute peak strength is not required, are thought to benefit considerably in the use of the as-extruded-Medart straightened product. Furthermore, since a minimum number of mill operations are required, such tubes are substantially cheaper than those having the high temperature heat treatment applied either to the as-extruded or to the cold-drawn condition.

High Nickel Alloy. The performance of one as-extruded high nickel alloy (34 Ni/21 Cr) has been such

as to justify the fairly general acceptance of the material for the ethylene furnace application and also for outside manifolding in steam-methane reforming furnaces where the temperatures are sufficiently low to permit the use of this condition. However, where hydrocarbon reforming at high pressures is practiced, especially in large diameter furnace tubes, the stresses developed are usually substantially beyond the capabilities of any of the wrought tube components of the furnace coil. The severity of the problem seems to be related in a complex fashion to the operating conditions for their effect upon the amount and nature of the solid forming, and especially the size of the particles. In the usual case, the stream velocity and the particle size are such that the path is generally axial, so that the maximum abrasive action is exerted upon the return bend rather than the tube. There have been cases of tube damage, but 18/8 carburized at a greater rate and so developed a surface of possibly greater wear resistance.

Although in the usual case, little difference is noted between the common heat-resisting alloys, some justification for the use of hard surfacing compositions has been claimed.

Chemical Properties. This final group of properties is mainly concerned with the various types and consequences of reaction between the

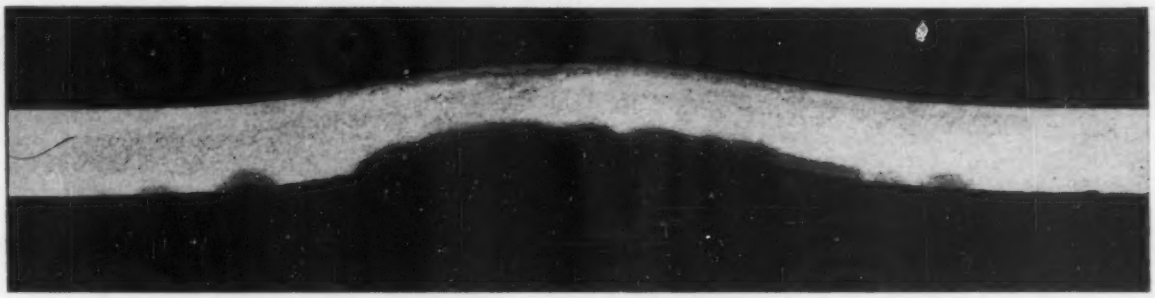

FIGURE 2—During decoking this heater tube retained small patches of coke which caused overheating and bulging.

alloys, even when specifically heat treated to coarsen the grain size and thereby secure maximum strength. In such cases, the choice of alloy and form is clearly directed to centrifugally cast tubes for reasons mentioned above. There have been several reforming installations for production of ammonia synthesis gas where the pressures have been somewhat less than the maximum, perhaps 90-115 psi, and the tubes have been of smaller diameter and heavier wall thickness so that the lower strength of as-extruded and Medart-straightened high nickel alloy (34 Ni/21 Cr) could be safely employed. In one of these installations on the West Coast, the alloy has been performing satisfactorily without any reported distress for more than 33,000 hours. There have been other very recent high pressure installations involving a larger tube size where the resulting design stress has necessitated the application of a deliberate grain-coarsening heat treatment to the as-extruded alloy.

Abrasion. The coke which apparently is formed more or less inevitably during ethylene pyrolysis is extraordinarily dense and hard—in some cases capable of scratching glass—and at the kinetic energies supplied by the high mass velocity, exerts a substantial abrasive effect upon the these have generally been associated with some unusual condition, such as where a tube has sagged from overheating or inadequate support or where disalignment of joined surfaces may cause local turbulence.

The fact that the scouring action of the coke particles is confined to the return bend castings is fortunate in a way, since it is possible to obtain smooth and constant radii on inside and outside bends, and in one popular design, to cast a much heavier section in the outside wall in order to extend the life.

In comparison with the hot hardness range available in the common heat-resisting alloys, the hardness of chemical coke is of a different order of magnitude so that slight differences in base composition of the wrought alloys and castings would not be expected to produce a noticeable effect. On the other hand, in their paper on the selection of alloys for ethylene heater service, Buell and Weber[1] state that abrasion by coke is the chief cause of tube failure. They further describe the general experience where Type 304 tubes at the highest temperatures in the radiant section exhibited appreciably better resistance to erosion than Type 310. This well-documented variation in behavior is difficult to explain unless conditions were such that the alloy surface and the surrounding environment. In furnace tube applications, the forms of chemical or corrosion behavior of major interest include the effect of alloy composition upon reaction with the hydrocarbon gas streams being processed and with the combustion products of the various fuels by which the tubes are heated. The relative importance of several high temperature corrosion mechanisms must be considered for each particular set of operating conditions, and these factors can be briefly discussed as follows:

Resistance to oxidation is essential in the sense that any practical tube alloy must be able to withstand thousands of hours in the hot combustion gases without appreciable loss of load-carrying section by conversion to oxide or scale. For the most part, this requirement is not difficult to achieve, since where metal temperatures are likely to attain 1550-1600 F. and above, only the 18/8-base compositions would be considered prone to excessive scaling. The remaining compositions in this discussion that contain significantly either higher chromium contents or else more than 20 percent nickel have acceptable oxidation resistance through the formation of tightly adherent protective films. This satisfactory behavior is further benefited by the fact that the heating

is more or less uniform and continuous—a condition tending to minimize the flaking of the otherwise protective oxide. In applications involving drastic heating and cooling cycles from temperatures on the order of 1,700-1,800 F. and above, it has been shown that much higher nickel contents are necessary to insure freedom from scale loss by spalling.[10]

Carburization. One commonly encountered type of attack when high temperature alloys are heated in contact with hydrocarbons or carbonaceous atmospheres is broadly identified as carburization. This does not involve corrosion in the usual sense of metal wastage, but the consequences of absorption and diffusion of carbon into the alloy are more often associated with a marked change in mechanical properties in the direction of lowered ductility and resistance to impact. The occurrence, extent, and degree of embrittlement resulting from carburization depend, among other factors, upon the alloy composition, the temperature and time of exposure, and especially upon the chemical makeup of the environment.

There has been extensive carburization testing of different alloys in various types of industrial conditions. In general, such tests indicate that of the major alloy components, a high chromium content is most useful in imparting carburization resistance, with the effect of this element being intensified in the presence of higher nickel contents.[11] Of the minor elements, silicon appears to be of some benefit, but, unfortunately, principally in the iron-base alloys where its practical utility must be carefully balanced against its tendency to promote the formation of sigma within the structure. There appear to be indications that the strong carbide forming elements, such as titanium and niobium, reduce the extent of carburization, but the improvement is temporary and lasts only until all of the stabilizer has been converted to the carbide, after which the matrix behaves as though no stabilizer were present.

The absorption of carbon appears to be hindered by the existence on the heat-resisting alloy surface of a dense and continuous oxide film, as might have been acquired in an earlier heating operation. Similarly, the carburization process is evidently suppressed by the co-presence of compounds in the gas stream that favor the formation and maintenance of a surface oxide. One component that is highly effective as an oxidizing agent to chromium-containing alloys, even in the presence of a large proportion of hydrogen or hydrocarbon, is water vapor. For this reason, in steam-methane reforming where a large burden of water vapor is carried in the feed, conditions are oxidizing to the furnace tube alloy and no carburization would be expected. In fact, it appears that the operating environment may favor a reverse process, i.e., decarburization, since in the case of an as-extruded 78 Ni/15 Cr furnace tube it was found that several thousand hours of operation produced a detectable reduction from the original carbon content of the alloy.

In a similar manner, the pyrolysis of ethane or propane in ethylene heaters almost always requires the incorporation of substantial percentages of water vapor, and under these conditions the atmosphere itself does not seem to be carburizing, at least to Type 310 and 34 Ni/21 Cr alloy, which have been widely and successfully used in this application. On the other hand, there have been several cases where both alloys, in addition to others such as 78 Ni/15 Cr and Type 316, have been extensively and deeply carburized by hydrocarbon streams having low or negligible water vapor contents.

Coke Deposits. A complication in the operation of ethylene heaters is the eventual accumulation of coke within the tubes, requiring interruption of production and decoking by controlled combustion. Furnace operators appreciate that this decoking cycle involves more hazard to the tubes than regular operation. In metallurgical terms, the major possibility of risk is associated with the local overheating of an area on the tube by more or less uncontrolled combustion of a coke deposit. The fact that overheating is usually confined to relatively small areas suggests it may be caused by small patches of coke that remain after the more carefully controlled burning cycle. Local overheating that occurs causes local expansion or bulging, and the increase in temperature, which in some cases may be great enough to cause melting of the alloy, considerably accelerates the absorption of carbon into the metal immediately beneath the deposit. The result is that the ductility of the overheated and plastically deforming area is quickly reduced by carburization to the extent that a rupture through the bulge occurs. An example of this type of behavior, but one which did not result in actual rupture, is shown in Figure 2. This longitudinal section of a 34 Ni/21 Cr tube through a bulge that developed during decoking indicates the extent of carburization by the darkly etching areas within and toward each end of the upset. It will be noted that all carburization has occurred from contact with coke deposits and none from reaction with the atmosphere, which would be represented as a general and uniform etching effect.

Sulfur Attack. Another quite common form of high temperature corrosion involves reaction with sulfur-containing compounds in the environment. This type of attack may be so severe on some heat-resisting alloys that the need for obtaining adequate protection is often a dominant factor in guiding the choice of alloy composition. In general, the mechanism is one in which reaction occurs between the sulfur—usually as sulfur dioxide or hydrogen sulfide where hot atmospheres are concerned—and one or more of the constituents of the alloy to produce low melting metal sulfides. As pure metals, both iron and nickel behave in this fashion, but by far the more susceptible is nickel, in which the sulfide-metal eutectic has the remarkably low melting temperature of about 1190 F. and, in addition, has marked preference for forming a continuous film at the grain boundaries and so induces a very thorough embrittlement. Pure nickel represents an extreme case since the addition of iron, and especially chromium, not only elevate the fusion temperature of the complex sulfide phase resulting, but, of equal importance, alter the mode of formation from continuous intergranular films to isolated globules that are much less injurious.

In the selection of alloys for high temperature service, it is a more or less fundamental consideration that

in environments containing appreciable concentrations of sulfur the use of high-nickel alloys is to be avoided in preference to compositions lower in nickel and higher in iron. This is especially the case in atmospheres that are reducing to the alloy, such as dry hydrogen-hydrogen sulfide mixtures where no oxide would form on the surface. When conditions permit the simultaneous formation of oxide, as in an atmosphere of combustion products containing sulfur dioxide, the oxide film provides a degree of protection which generally limits the extent of penetration of the sulfide phase.

In the production of ethylene by ethane or propane cracking, the problem of sulfidation is almost always of small consequence since the feed materials, for process reasons, are very low in sulfurous impurities and the fuel by which the coil is heated is usually a low-sulfur natural gas. In the production of ethylene by cracking gas-oil or naphtha with superheated steam, it is possible to employ feeds containing up to several percent sulfur, and in such cases the alloys used have been Type 310 and 309 stainless steel. In one installation a low-sulfur operating condition has permitted the use of as-extruded 34 Ni/21 Cr tubing.

In steam-hydrocarbon reforming where a nickel catalyst is employed, it is essential that the sulfur concentration in the feed be maintained at a very low value in order to prevent poisoning and an unfavorable conversion. If relatively large amounts of sulfur are available to attack the catalyst, the result is not only to destroy its activity, but may be to react with the disseminated metal to form nickel sulfide, which is molten at the operating temperature and, furthermore, contains about 24-25 percent sulfur. The consequences of a similar situation are shown in Figure 3, depicting the cross section of a 78 Ni/15 Cr alloy reforming tube in which the nickel catalyst was inadvertently sulfidized to the molten compound which thereafter attacked the heat-resisting alloy. It is highly unlikely that the sulfur concentration in the feed which caused this failure would have produced detectable damage to the 34 Ni/21 Cr alloy were it not for the very large concentration factor obtained in the formation of the molten nickel sulfide.

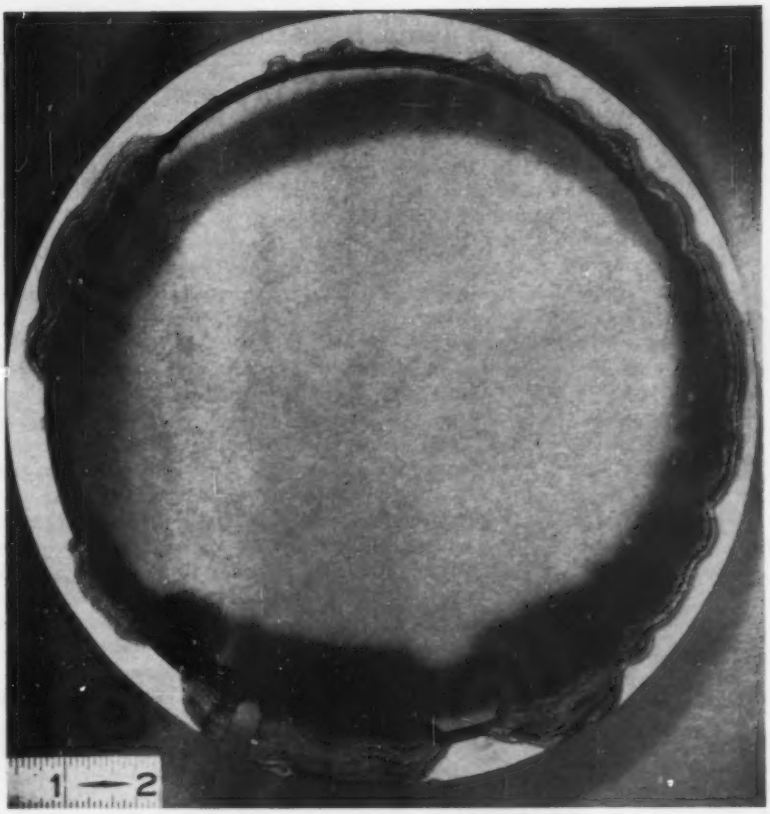

FIGURE 3—The nickel catalyst reacted with sulfur in the feed forming nickel sulfide which then attacked this 34 Ni/21 Cr heater tube.

Effects of Slag. Some Bunker "C" grades of fuel oil have a fairly high sulfur content and contain vanadium and sodium compounds as impurities. On combustion, these elements form low melting slags which cause severe corrosion by fluxing the protective film.[12, 13]

The corrosive activity of the oil-ash slag does not seem to consume itself with time. Instead, the attack continues as long as the temperature is high enough to provide the molten state regardless of resumption of firing with a harmless fuel.

The implication is that the use of a vanadium-containing residual oil, even for a few days, is likely to deposit a highly corrosive slag which will ultimately cause premature tube failure.

Another form of high temperature corrosion results from welding slag left on tube surfaces. Temperatures as low as 1400 F may promote the formation of a liquid phase from the slag residue. This liquid acts as a flux in dissolving the protective oxide film.[14]

Whenever the welding process involves a slag, it is highly desirable to clean all welds and adjacent areas of residual slag for which grit or sand-blasting are preferred methods.

There appears to be no adequate metallurgical solution to these kinds of corrosion; since, all heat-resistant alloys are suceptible to marked deterioration under the action of these slags. The only practical solution is to take the precautions necessary to avoid the presence of the corrodents on the tubes.

Catalytic Effects. In the manufacture of ethylene by the usual method of cracking ethane or propane, the maximum utilization of the furnace coil requires that interruption of production for decoking be as infrequent as possible. A common practice is to adopt a regular schedule of decoking the tubes, since it appears preferable to remove deposits at a very early stage of formation rather than after a sufficient thickness has accumulated to produce a noticeable change in operating characteristics. When a cracking

coil has, for one reason or another, been allowed to develop a heavy deposit of coke, its removal by controlled combustion with steam-air mixtures requires much greater care in order to avoid severe damage to the tubes. Since the thermal efficiency, product yield, and hazard of tube damage, all are apparently related to the frequency of decoking, the question is occasionally raised as to whether the various heat-resisting alloy compositions differ in ability to promote carbon formation by some type of catalytic activity. At one time it was fairly widely accepted that the nickel content of the tube alloy should be as low as possible, and certainly no more than absolutely necessary if serious coking difficulties were to be avoided. Plant experiences that would lend factual support to such opinions have been most difficult to obtain. There have been cases of excessive and rapid carbon formation with nearly all alloy compositions that have been used in the application, but whether the occurrence was due actually to catalysis rather than to some deficiency in furnace operation is not clear. It is interesting that some operators have expressed the belief that all heat-resisting alloy tube surfaces, irrespective of chemistry, display a certain amount of catalytic activity in encouraging the decomposition of paraffin hydrocarbons into tars, carbon, and coke. This activity is said to be suppressed or eliminated only by proper operating procedure, which may include special attention to such factors as precise adjustment of temperature profile along the length of the coil, injection of steam with the feed, pre-oxidation of the tube wall after decoking, or low olefin content of the feed.

Of the numerous references appearing in the literature on the catalytic effects of metals on paraffin and olefin hydrocarbons, those which are especially pertinent to ethylene production are the summaries of Egloff and his associates,[15, 16] and the pyrolysis studies of Hurd and Eilers.[17] There is abundant evidence to indicate that at high temperatures the pure base metals, iron and nickel (and cobalt), are generally quite vigorous in decomposing hydrocarbons, with the formation of solid residues. The extent of catalytic activity, however, appears to be subject to wide variation, depending upon the type and method of preparation of the metal surface, and particularly the presence or absence of certain catalytic poisons. As far as commercial alloys are concerned, the presence of a substantial amount of chromium seems to suppress the activity to a low order, and it has been reported that a 28 percent chromium steel and a 20 percent chromium-balance nickel alloy have exhibited essentially non-catalytic behavior toward propane at about 1300 and 1475 F., respectively. On the other hand, an 18/8 tube has been found to be very active in decomposing propane until the surface was poisoned with a small amount of hydrogen sulfide, after which it was completely non-catalytic.

These laboratory observations favor the conclusion that while the inner surface of a commercially supplied heat-resisting alloy tube might conceivably be capable of exhibiting some degree of activity, the possibility must be considered remote because of the likelihood of poisoning of the surface during production or in storage or by impurities that may be present in the process. In the latter respect, a factor that may be of considerable benefit is the use, for production reasons, of fairly large amounts of steam, but which would, incidentally, favor the formation and maintenance of an oxide film that presumably would have much lower activity than the bare metal surface.

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Skinner

Dr. E. N. Skinner is a staff metallurgist for International Nickel Co., New York. He received B.S., M.S., and Ph.D. degrees in physical metallurgy from Yale University, and has been employed by International Nickel since leaving college in 1939. From then until 1946 he was a staff metallurgist in the Research laboratory, Bayonne, N. J. Since 1946, Dr. Skinner has been with the Research and Development division in New York where he is in charge of the High Temperature Materials section, working in fields requiring heat and corrosion resistant materials, principally nickel-containing alloys. He once taught physical metallurgy at the Polytechnic Institute of Brooklyn, and is a member of AIME, ASM, ASTM and NACE.

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Estimate Cost of Fractionation Systems

These generalizations may be used to get a quick estimate of future fractionation costs

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A CONVENIENT building block in the establishment of an estimate of refinery and chemical plant is the fractionation system. Cost data on about 30 different fractionation systems designed by contractor in accordance with varied petroleum refiner practice, has been analyzed, resulting in some reasonable generalizations. Figure 1 represents the flow diagram for such a system.

A description of four typical fractionation systems is given in Table 1. Process equipment was for the most part of normal carbon steel design. Trays were mostly carbon steel, bubble cap type, with some of more expensive 410 stainless steel. The heat exchange surface tabulated includes condenser items which were specified with admiralty tubes. Pump items were centrifugal and of cast steel casings. Motors were 440 V class I Group D, explosion proof. Turbine spares were of cast iron casings.

Systems studied were all new units to be installed in new sites in free and clear area. A practical battery limit was assigned to each system enclosing equipment involved so as to eliminate the variables of offsite piping and utility runs.

Cost data in thousands of dollars are given in Table 2. Process equipment costs (2) are summations of equipment costs as itemized (1a to e) on a July, 1957, basis. Other direct material costs (3) include foundation, building, structures, piping items, electricals, fireproofing, insulation (delivered and erected subcontract) paint and mechanical handling equipment. Total direct materials (4) represent the cost of all equipment and materials which become a permanent part of the plant. Erection cost (5) is on a Gulf Coast basis and includes all labor and field staff expense besides construction equipment on a rental basis, small tools and temporary construction facilities. Home office costs and fees (6) include engineering, design, purchasing, expediting, reproductions and communications as well as a nominal contractor's fee for general administrative overhead and profit. The selling price (7) is the summation of direct materials (4)

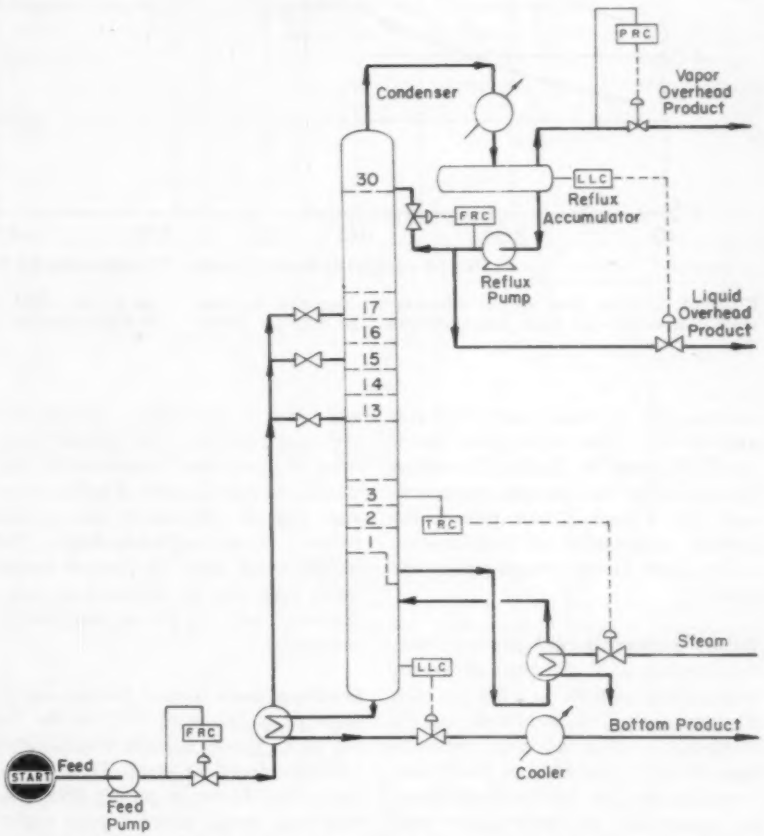


FIGURE 1—Four typical fractionation systems are reported to show how these generalized cost data were obtained.

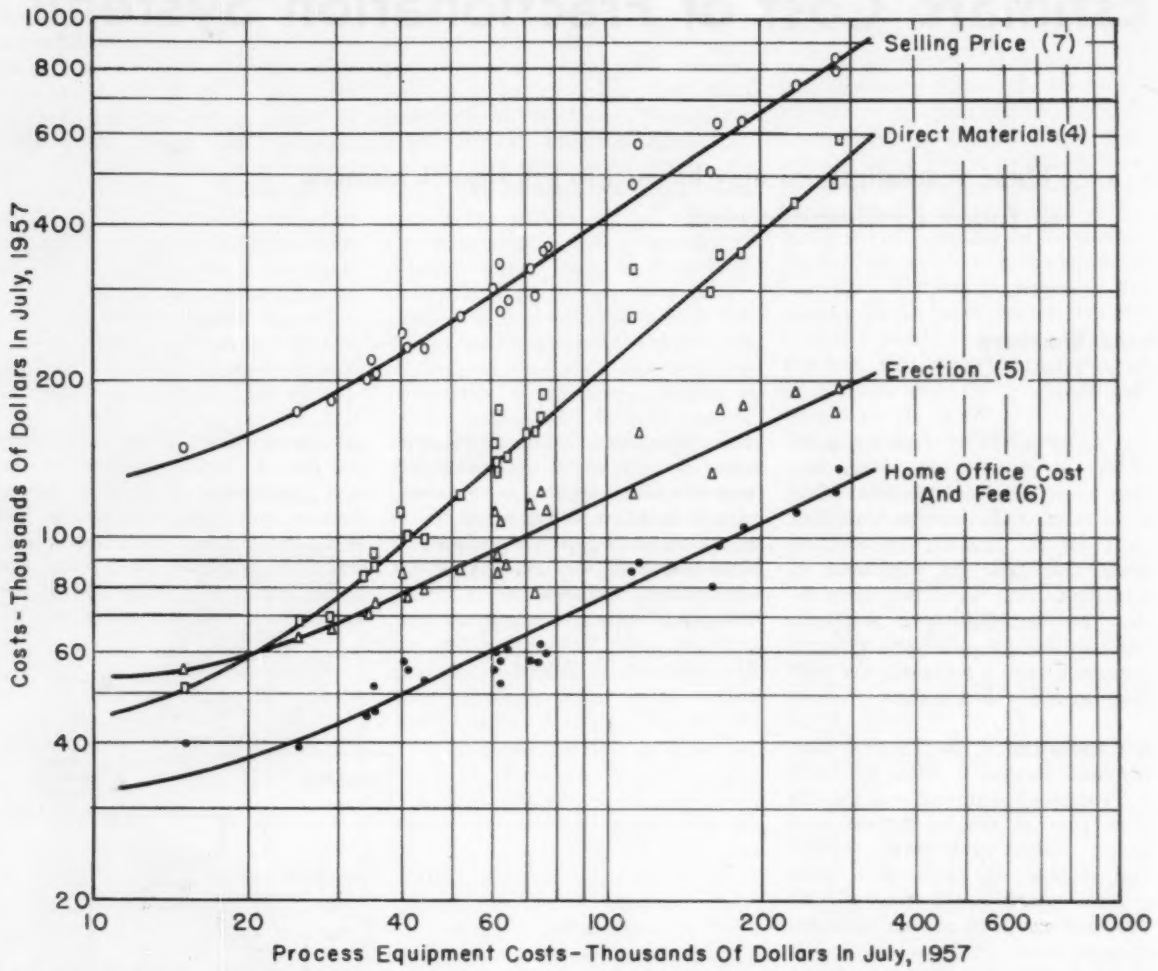


FIGURE 2—Cost data on 30 different fractionation systems were compiled to get these generalizations. The data are based on a July, 1957, price structure. The systems were all new to be constructed on new sites in a free and clear area.

erection cost (5) and home office cost and fee (6). The selling price factor (8) is obtained by dividing the selling price (7) by the process equipment cost (2). Figure 2 is a plot of the various components of fractionation system costs versus process equipment costs.

Direct materials cost offers a linear relationship with process equipment, with a slope of 0.82 on a log log plot. The scattering of points is largely attributable to variation in specifications of other materials of these fractionation systems, that were designed by contractor in accordance with varied customer's specifications. Complexity of piping and instrumentation and severity of piping specification are major factors. In general however, the customer's conservative approach to specification of other materials will be reflected to some extent in the process equipment design. The incidence of alloy in process equipment may also be reflected in other materials such as piping and instrumentation.

Erection costs versus process equipment costs (slope of 0.47 on the log log plot) shows a more considerable variation from the mean. Here again, the major factor is piping specification and detail. Since piping represents about one-third of erection costs, specification and layout have a considerable effect upon erection cost.

Alloy in process equipment should be adjusted to a carbon steel basis if erection cost is to be estimated from this data, since erection of such equipment and alloy shop fabricated piping requires little more cost. No field fabrication of alloy piping or special alloy welding costs are included in the units plotted.

Home office cost and fee bear good linear log log relationship with process equipment costs, (slope = 0.46). These costs are also directly related to the customer's engineering staff and to his requirements as to records and procedures. Home office costs of a constractor are increased to the

extent that the customer indicates special requirements.

Alloy process equipment has little effect upon home office cost. Use of this data for estimate of home office cost and fee requires an adjustment to a carbon steel basis.

The selling price, a summation of direct material cost, erection cost and home office cost and fee varies with a slope of 0.67 on a log-log plot versus process equipment cost. A linear relationship exists except for that range of process equipment below $25,000. In this area costs of other materials, erection and home office are approaching pratical minimums which must be expended for these items of a fractionation system.

Selling price factors are plotted in Figure 3. This curve is very useful for approximation of delivered and erected selling price estimates from preliminary process equipment estimates. It must be understood that these approximations are based upon reasonable battery limit considerations and exclude offsite "tie-ins" such as a product run to tankage or new utility runs to the battery limits.

Adjustments may be made in approximate selling price to account for local considerations such as area wages, labor productivity and local weather by use of the erection cost indicated in Figure 2. For example, if local erection considerations would increase cost by 20 percent over Gulf Coast, a fractionation system consisting of $100,000 of process equipment would be estimated to cost an additional $24,000 (20% of $118,000).

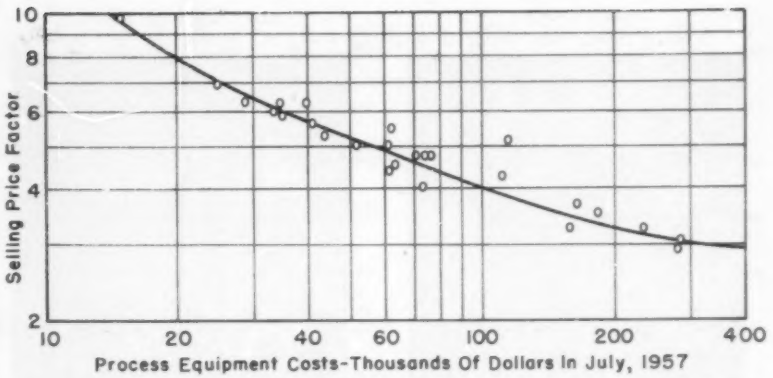


FIGURE 3—A reasonable selling price may be approximated by multiplying the process equipment cost by a selling price factor.

Revamp work or erection of a fractionation system within the area of an existing plant also requires adjustment in erection cost. Erection costs in such instance may generally be increased by 35 to 60 percent.

These steps can be taken to obtain an estimate of cost for a fractionation system:

- Based upon an estimate or quotation of process equipment a reasonable estimate of delivered and erected selling price (Gulf Coast basis) may be obtained by consulting Figure 2 or the use of selling price factor in Figure 3. Breakdown into direct materials, erection cost and home office cost and fee is available.
- Adjustments for local wage rates and labor productivity are possible by use of Figure 2.
- Erection cost may also be adjusted for revamp work.
- Estimate of "offsite tie-ins" must be added to these fractionation system estimates, if such connections are not immediately available at the battery limits of this system. # #

TABLE 1—Typical Fractionation Systems

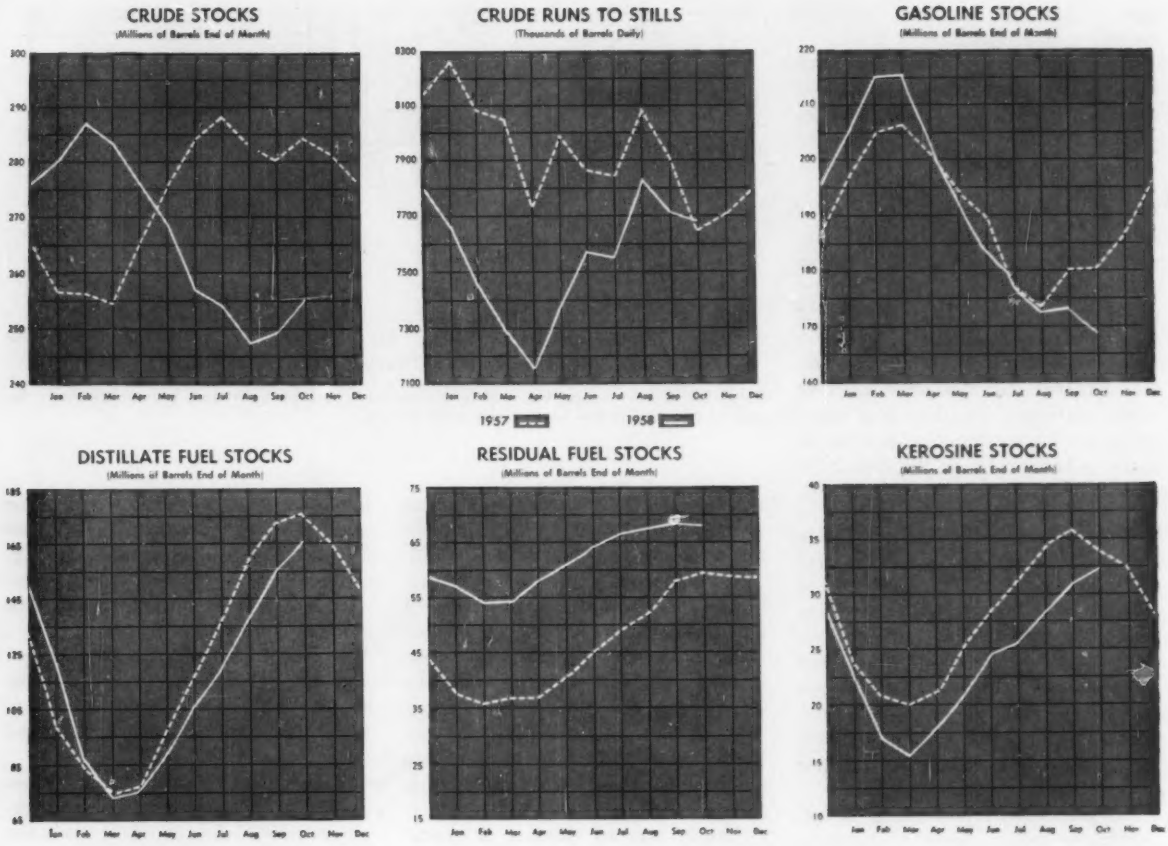
Process Equipment	Splitter	Debutanizer	Stabilizer	Debutanizer
Tower				
Diameter, ft.	12	7	7 & 4	3
Height, ft.	80¾	107	85	56
Thickness, in.	9/16	1	¾	7/16
Weight, tons	65	68	43	11
Trays				
Number	30	40	30	26
Area, sq. ft.	3400	1550	391	183
Drum				
Diameter, ft.	8	5	4	3
Length, ft.	20	15	15	9
Weight, tons	18	7	6	2
Exchanger Surface, sq. ft.	32,800	15,490	2420	2840
Pumps & Drives	4	4	2	2

TABLE 2—Cost Data.
(Basis: July, 1957)

Cost Items	Splitter	Debutanizer	Stabilizer	Debutanizer
1a. Tower	29	32	15	10
b. Trays	44	18	4	3
c. Drum	16	6	3	2
d. Exchangers	168	87	44	18
e. Pumps & Drivers	21	17	10	4
2. Process Equipment	278	160	76	35
3. Other Direct Materials	205	139	112	52
4. Total Direct Materials	483	299	188	87
5. Erection Cost	194	134	112	74
6. Home Office Cost & Fee	123	81	60	46
7. Selling Price	800	514	360	207
8. Process Equipment Factor	2.88	3.21	4.74	5.92

About the Author

Irwin Bromberg is manager of the Cost Control department of The Foster Wheeler Corp. He received his B.S. degree in chemical engineering from City College of New York in 1940, and his M.S. degree in chemical engineering from Polytechnic Institute of Brooklyn in 1950. He is a member of the American Association of Cost Engineers, and is a licensed professional engineer in New York.



Taking Stock

- Crude stocks still rising
- Gasoline stocks down once more
- Distillates continue to climb

U. S. Monthly Oil Trends

(THOUSANDS OF BARRELS DAILY)

	OCTOBER			Sept.	JANUARY-OCTOBER		
	1958	1957	% Diff.	1958	1958	1957	% Diff.
U.S. Crude Oil Production	6,910	6,860	+ 0.7	7,056	6,627	7,234	— 8.4
U.S. Nat. Gas Liquids Prod.	800	803	— 0.4	800	784	802	— 2.3
U.S. Total Imports	1,720	1,526	+12.7	1,643	1,650	1,532	+ 7.7
East Coast Crude Imports	709	759	— 6.6	738	754	745	+ 1.2
Total Crude Imports	908	1,022	—11.4	947	934	1,004	— 7.0
Total Refined Products	815	504	+61.7	696	718	528	+36.0
Total New Supply	9,430	9,189	+ 2.6	9,499	9,061	9,569	— 5.3
Stock Changes All Oils (Daily)	+452	+142	.....	+750	—29	+273	.....
Total Demand All U.S. Oils	8,978	9,046	— 0.8	8,749	9,091	9,296	— 2.2
Gasoline Demand	4,017	3,940	+ 2.0	4,140	3,974	3,967	+ 0.2
Distillate Fuel Demand	1,489	1,643	— 9.4	1,259	1,679	1,726	— 2.7
Residual Fuel Demand	1,409	1,455	— 3.2	1,258	1,425	1,571	— 9.3
Domestic Demand, All Oils	8,678	8,687	— 0.1	8,449	8,810	8,689	+ 1.4
Export Demand, All Oils	300	360	—16.7	300	280	607	—53.9
Crude Runs U.S. Refineries	7,696	7,650	+ 0.6	7,703	7,546	7,952	— 5.1
Domestic Crude Runs	6,764	6,697	+ 1.0	6,779	6,618	6,970	— 5.1
Foreign Crude Runs	932	952	— 2.1	927	928	982	— 5.5

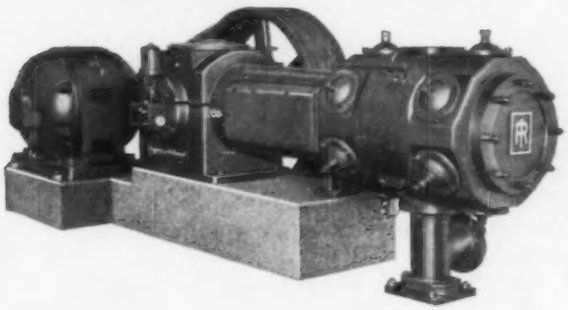
	TOTAL U.S. STOCKS Millions of Barrels End of Month				STOCKS EAST OF CALIFORNIA Millions of Barrels End of Month			
	October			Sept.	October			Sept.
	5958	1957	% Diff.	1958	1958	1957	% Diff.	1958
Crude Oil	255.7	284.5	—10.1	249.3	222.3	245.9	— 9.6	209.6
Gasoline	168.6	180.9	— 6.8	172.6	146.2	155.0	— 5.7	150.0
Distillate Fuel Oil	166.3	176.4	— 5.7	156.1	151.8	159.3	— 4.7	142.0
Residual Fuel Oil	68.2	60.0	+13.7	68.9	33.8	35.2	— 4.0	34.3
Kerosine	32.4	34.4	— 5.8	31.3	32.0	34.1	— 6.2	30.9

Source: Except for latest two months, all data from U.S. Bureau of Mines. Data for last two months from American Petroleum Institute weekly reports and U.S. Bureau of Mines weekly crude stock report; except U.S. Natural Gas Liquids Production and Demand figures which are from WORLD OIL.

NEW COMPRESSORS

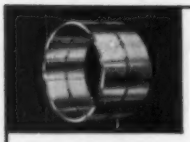
...with heavy-duty features proven in larger Ingersoll-Rand compressors

ESH* (horizontal)



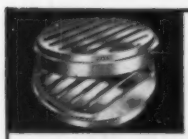
ESV* (vertical)

*The same compressor in either horizontal or vertical arrangement – 20 to 150 hp sizes, single-and multi-stage, pressures up to 5000 psi and vacuums.



Full-floating aluminum bearings never need adjustment

The full-floating bearings "roll with the punch," taking each thrust on a different portion of the shell. They are foolproof, and never require fitting or adjustment. Main and crankpin bearings are made of I-R's special aluminum bearing alloy, which has higher load capacity and better heat conductivity than other bearing materials.



Air-cushioned Channel Valves give unmatched performance

Known the world over for lasting efficiency, dependability and quiet operation, Ingersoll-Rand air-cushioned Type A Channel Valves are entirely different in design and principle from any other valves in use. Type A Channel Valves were developed especially for modern compressor speeds, and feature a separate stainless-steel seat plate which can be reversed or replaced for new life.

Never a need for adjustments– frame is kept sealed!

Here's an entirely new line of compressors, built to run longer — much longer. They're more compact, more efficient, and require less attendance, less maintenance. They offer greater capacity in less space, and are ruggedly built and highly refined to take years of continuous hard service.

All running parts are precision-machined and need no fitting or adjusting, so the frame is sealed — dirt stays out, and the major causes of wear are eliminated!

There are many design features—including filtered force-feed lubrication and full-floating self-adjusting metallic packing — that have heretofore been found only in larger Ingersoll-Rand compressors. Let your I-R representative tell you more about these new compressors, and how they can save you money.

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Valuable Reading Ahead

Here's a quick run-down on what's presented in this month's non-technical sections. These departments will keep you right up-to-date with what's new and different in this rapidly changing oil industry.

You Need to Know

Information you need to know about the companies which service and supply the oil, gas and petrochemical processing industries will be found in "What Suppliers Are Doing." This department will help you keep up with those who serve your plant, personnel changes in their companies, and any extension of facilities or services which might benefit your operation.

Keep Going to Page 214

Who's Building

International Synthetic Rubber Co., Ltd., has completed its new $16.8 million plant at Hythe, England. In this month's "Who's Building" lead story, you'll see the complete statistical summary of this plant's operation. This section is also full of data on dozens of other projects being planned or under construction throughout the world. To keep abreast of industry construction progress . . .

Keep Going to Page 153

Portable Elevators

Ever thought about how much time your plant loses every year in getting men to high work stations, and how fatigued they must be after climbing stair after stair? Well, several major oil companies have recently solved the problem by using a new type demountable elevator approved for both personnel and materials transfer. To learn all the details on this money and time saving device, read this month's "What's New in Equipment."

Keep Going to Page 236

Up the Ladder

Yes, each month hundreds of the industry's men go "up the ladder"—the promotion ladder, that is. New jobs are opened—old jobs are filled by new men, and you may know many of them. Take a look at "What's Happening Among Men in the Industry" to see what's happening to the men you know, and those you would like to know.

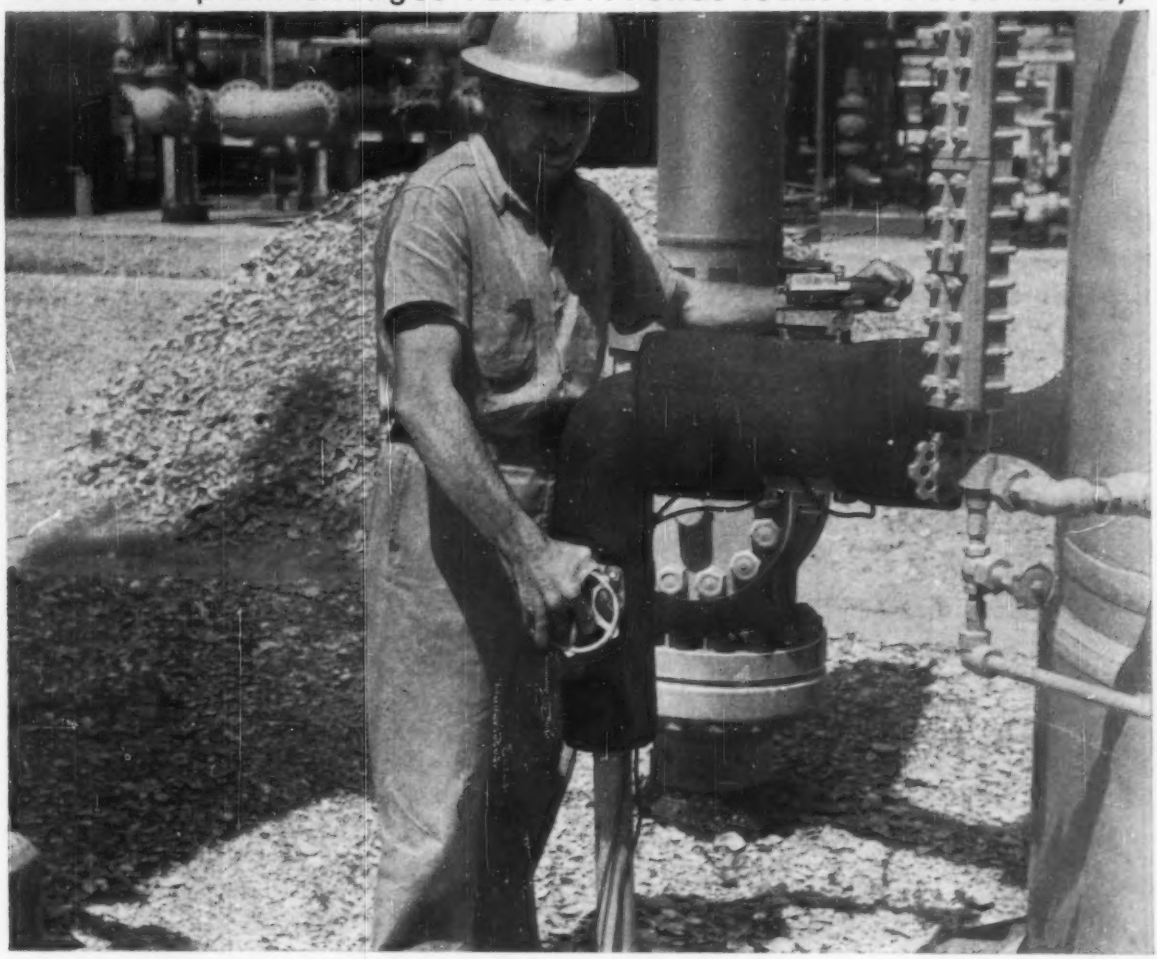
Keep Going to Page 193

Knowledge is the Key

Knowledge is the key to success, at least one of them. And, what better way is there to help you gain the knowledge you need to advance than through a good book on a subject important in the industry. You can learn about some of the better books by reading this month's "Reviewing New Books."

Keep Going to Page 206

Gasoline plant changes valves . . . ends leaks . . . saves money



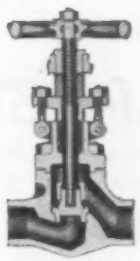
Crane Valves Stop Trouble in Severe Blowdown Service

This large Southwestern gasoline plant was troubled by leaky plug type valves used on 900-pound blowdown service lines from gas scrubbers. Water, scale, dirt and other foreign matter cut out the plugs and seats. Valve maintenance costs rose and scrubber efficiency dropped.

It's more than a year since the plant replaced the more costly plug type valves with Crane 1-inch, 600-pound forged steel globe valves. Today these Crane valves, operated several times daily, continue to seat tightly.

With the leakage problem licked, the plant has saved money on maintenance, and improved the efficiency of scrubber operations.

Got a leaky valve problem of your own? Your Crane Man will have the economical answer. He and Crane have been providing solutions to valve and fittings problems for many years—all based on thorough knowledge of oil and gas industry needs . . . Crane know-how in design and manufacturing . . . Crane dependable quality. Take it up with your Crane Man on his next call.



Rugged Crane 600-pound globe valve seating is famous for resistance to foreign matter and wire-drawing. Better design and materials do it!

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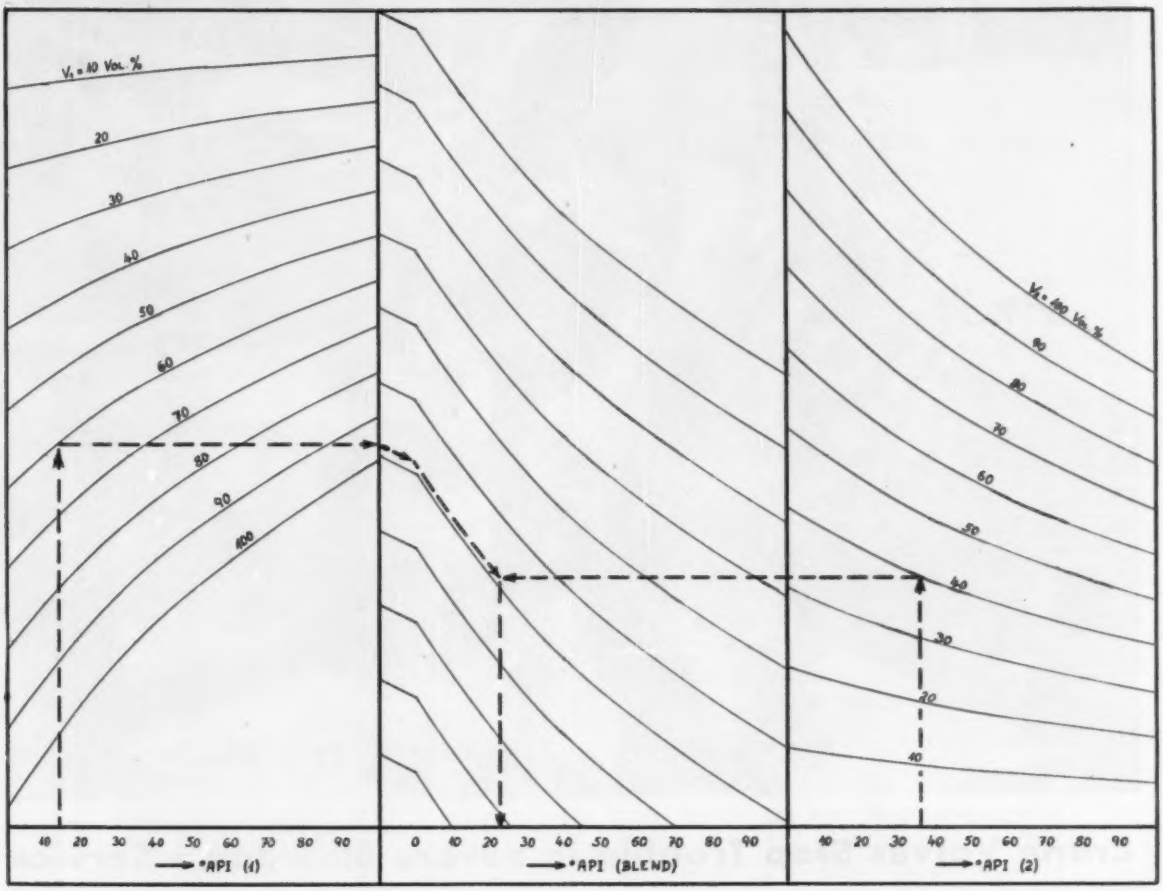
For more data on advertised products, use Readers' Service Cards, last page.

How To Do It . . .



API Gravity of Blend Easy to Find

In order to find the API gravity of a blend, the gravity of the components and their percent of the blend must be known. If the component quantities are known, it's a simple procedure to follow the curves to find the gravity blend.

Example: If you blend a 14 degree API pitch (60 percent) with a 36 degree API cutting stock (40 percent), the resulting fuel oil will have an API gravity of 22.5 degrees, as obtained from the nomograph. The calculated result would be 22.1 degrees API.

This idea was submitted by Klaus Loth, Empresa Nacional Del Petroleo, Concon, Chile.

Plastic Stops Rupture Disc Corrosion

Rupture discs are made of thin metal in order that a specified pressure will rupture the disc, preventing injury to the system equipment. If the system contains a corrosive material, there is a good possibility that the rupture disc will be corroded to such a degree that its strength, and therefore its pressure holding ability, has been impaired. The result is that the disc will rupture prematurely. A simple solution is to place a thin sheet of plastic on the stream

Monel Bubble Cups and Tray for top of new fractionating tower completely engineered and fabricated by Fritz W. Glitsch and Sons, Inc., Dallas, Texas. Notice Monel weirs and baffles.

Here's where Monel proves year-after-year resistance to common tower-top corrosives

Tower-top corrosion *can* be held within practical limits.

Monel* nickel-copper alloy bubble caps proved *that* long ago. Their record . . . at temperatures up to 500°F. . . . shows outstanding resistance to the aqueous hydrochloric and sulphuric acids and the corrosive salts commonly present in this critical upper section.

Today, for towers handling corrosive streams, Monel alloy is preferred in this location.

The men with the sharp pencils say Monel alloy costs less per pound than other commercially available alloys able to withstand the corrosion in tower tops.

Fabricators such as Fritz W. Glitsch & Sons, Inc., find it is easy to form . . . lends itself well to lined or clad construction. Increasingly, they find it specified not only for caps and trays but also for distribution pipes, fittings, linings, the shell itself and overhead condensers.

Another advantage. Monel equipment can be field erected and easily repaired in the field. No heat treatment after welding is required to maintain corrosion resistance.

How is your tower down-time record? If it's not what it should be and corrosion is the cause, look into the possibilities of Monel alloy construction. Simply write Inco's Corrosion Engineering Section. *Registered trademark

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HEAVY SOLIDS with good coverage . . . HEAVY BUILD 5 to 15 mils per coat without sacrificing film quality . . . MINIMUM NUMBER OF COATS due to heavy build feature, saves labor . . . WIDE CHEMICAL RESISTANCE — all PLASITE formulations have excellent overall chemical and specific superior resistance . . . HIGH TEMPERATURE RESISTANCE from 350° to 400°F. on Dry Film basis . . . EXCELLENT BOND — Primers are not required on white blasted steel surface . . . AIR DRYING Field applications without baking or insulation.

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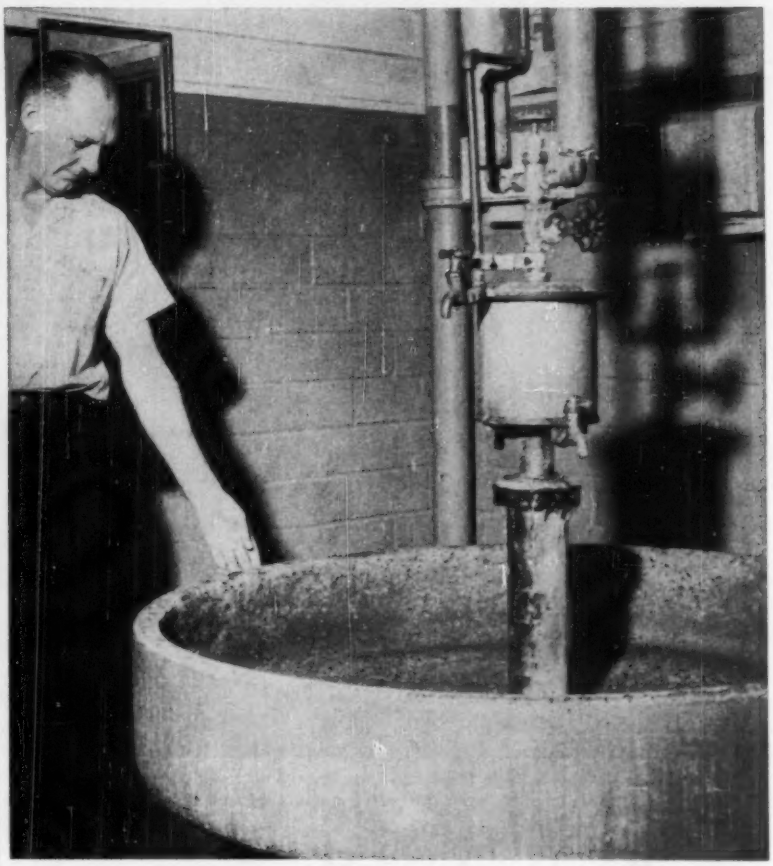
How to Do It . . .

side of the rupture disc when installing. The plastic will prevent corrosion of the disc, but is not strong enough to prevent a rupture in case rupture pressure is exceeded in the system.

This idea was submitted by R. L. Owens, Atlas Metal Protection Co., Houston.



Wash Fountain Can Be Repaired in Place

An inexpensive and quick method for repairing wash fountains "in place" was recently devised. The idea is to mix a compound composed of floured silica and liquid glass fibers which is applied to badly erroded fountains. The result is a greatly improved appearance and better service and safety in these installations.

This idea was submitted by Martin J. Felps, Ethyl Corp., Baton Rouge, La.

$$ Your Ideas Are Valuable! $$

At least $10.00 will be paid for each idea accepted for "How To Do It." All you need to do is write a brief note telling about your idea, then attach a photo or sketch (if needed), and mail it to Editor, Petroleum Refiner, P. O. Box 2608, Houston.

It's Easy to Haul This Skid-Mounted Water Tank

When one refinery foreman wanted to rig up a portable water tank, he found some used, three-inch boiler flues and some reverse turns in his junk yard and rigged up the skids, as shown. The skids were made by simply making four welds at the ends to form the frame, and stiffening them with braces at the front and back. The tank was then mounted and tied down to a cradle between the skids. With this mount, the tank can easily be pulled onto a truck from the front or the back.

This idea was submitted by Harry Hess, Houston.

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There are shorter ways — quicker ways — to make gaskets, but there's only one Flexitallic way.

Each Flexitallic Spiral-Wound Gasket is made to meet a specific sealing requirement. The flange design and the bolt load determine the density of the gasket — compression response is directly related to service. And then, with the most exacting mechanical controls, each Flexitallic Gasket conforms to specification.

Result: the right gasket for the right flange, to make the proper seal.

In the severest service — thermal and physical shock, corrosion, vibration, and unpredictable joint stresses — the Flexitallic Spiral-Wound construction compresses like a spring and then rebounds when the bolt load is relaxed.

For genuine Flexitallic Gaskets, look for Flexitallic Blue—the blue dye in the Canadian asbestos filler. It identifies the Spiral-Wound construction pioneered by Flexitallic in 1912.

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8th & Bailey Sts. Camden 2, N. J.

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SPIRAL-WOUND GASKETS

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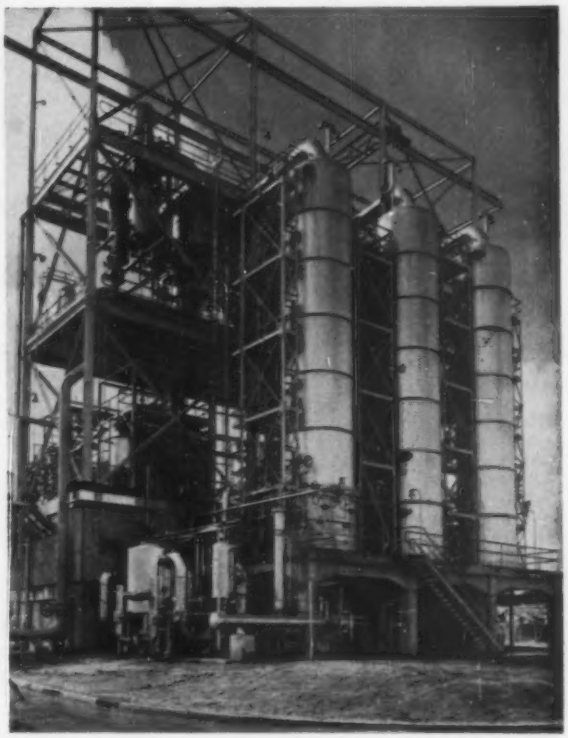
*Flexitallic is a registered tradename. No one else can make a Flexitallic Gasket. Look for *Flexitallic Blue* — it's our exclusive blue-dyed Canadian asbestos filler.

Who's Building . . .

STATISTICAL SUMMARY

Annual Production Capacity, tons	70,000
Area of Plant Size, acres	54
Area Covered by Installations, sq. ft.	280,000
Cost of Constructing and Equipping Plant, inclusive of Site Clearance, million	$2.85
Number of Employes	400
Storage Tank Capacities (Examples):	
Butadiene, gallons	420,000
Styrene, gallons	290,000
Process Oil, gallons	145,000
Antioxidant, gallons	40,000
Salt Water, gallons	1,200,000
Water (Other Categories), gallons	112,000
Latex, gallons	150,000
Estimated Pipeline Mileage Within Plant Boundaries (all liquids), miles	Over 50
Annual Butadiene Consumption, tons, approx.	50,000
Annual Styrene Consumption, tons, approx.	13,000
Fuel Oil Consumption, gal. per year	3,000,000
Electricity Consumption, kilowatt hours	25,000,000
Compressed Air Consumption, cu. ft. annually	450,000,000



Picture at right shows The International Synthetic Rubber Co., Ltd.'s recovery building at new Hythe plant.

UK's Synthetic Rubber Capacity Soars

New plant at Hythe makes England independent of overseas rubber sources, opens way for export

The new $16.8 million installation of International Synthetic Rubber Co., Ltd., at Hythe, England, is Britain's pioneer venture into the quantity production of general purpose synthetic rubber. With an annual output capacity of 70,000 long tons a year, it makes the United Kingdom independent of overseas sources of this material and, in addition, is in a position to export substantial tonnages.

ISR produces styrene butadiene rubber. Its main ingredients are, as the name implies, styrene and butadiene, in the ratio of three parts of the latter to one of the former. Its butadiene requirement is met by the Fawley refinery of Esso Petroleum Co., Ltd., 1.75 miles from the Hythe plant. Butadiene is piped between the two installations. Styrene suppliers are Forth Chemicals Corp. at Grangemouth and Shell Corp. at Partington. It is transported in road, rail and sea tankers. The Hythe installation, which occupies a 54-acre site, covers 280,000 square feet. It was built in 16 months, beginning in February 1957. It started first production the following March and attained full output on July 20, 1958.

Dow Chemical Co. has completed its two-year, $65 million construction program at Plaquemine, La., near Baton Rouge. The five major units put into operation will produce caustic soda, chlorine, hydrochloric acid, vinyl chlo-

ride, trichloroethylene, perchloroethylene ethylene dichloride, chlorinated solvents, and glycols and oxides of ethylene and propylene.

India reports that Rumanian experts have begun work on the construction of a modern oil refinery in Asam with a yearly capacity of 750,000 tons. The refinery will be built under the terms of an agreement signed recently between the two companies.

Rumania will supply all equipment for the refinery and will give assistance for the carrying out of Indian projects for development of the oil industry.

It was understood the construction of the refinery in Asam would cost about $17 million.

Caltex (Africa) Ltd. has applied for the establishment of an oil refinery in Durban, South Africa, according to the Durban City Council's General Purposes Committee. Caltex Co. also has expressed interest in establishing a refinery in the Bayhead area.

The Durban City Council had previously rejected an application by Shell Oil Co. (South Africa), to build a refinery on reclaimed land on Durban Bay because of the fear of air pollution. The council said it would help the company find an alternative site.

Shell Chemical Corp. will begin construction of a phenol unit at its Houston Deer Park plant early in 1959, with completion planned for late 1959. Most of the unit's production will be used to manufacture bisphenol A, one of the two principal ingredients in the company's adhesive and surface-coating resins. Shell Oil Co. also will take a share of the phenol. The unit will produce acetone as a co-product. Cost of the project was not divulged. The M. W. Kellogg Co. will construct it.

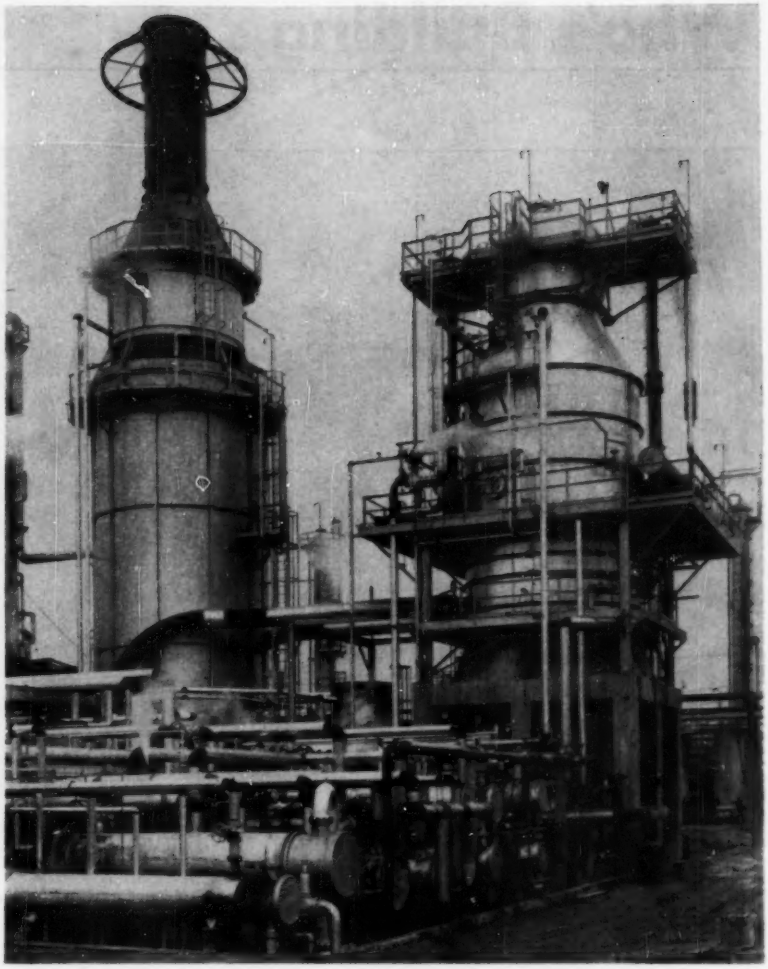
Continental Carbon Co. plans an expansion project at its carbon black plant in Ponca City, Okla. Involved will be the enlargement of the facility's furnace black capacity by 50 percent.

Work on the project, which will boost the plant's capacity from 50 million pounds to 75 million annually, will start within the next month. Completion is expected by fall of next year.

Danubia Petrochemie A. G., a new company, has been established by the Italian chemical organization of Montecatini and an Austrian organization, Stickstoffwerke A. G., of Linz.

The new company will build a petroleum chemical derivatives plant in Vienna, Austria at Schwechat, where a large oil refinery will be erected by Austrian interests. The facility will have an initial capacity of 11 million pounds of polypropylene annually.

Petroleos Mexicanos has completed its Monterrey-Monclova gas line along with a 20,000-bpd catalytic cracking plant and 11 other installations needed to put it into operation. The plant was built at Azcapotzalco for $20 million.



Ashland Oil & Refining Co., had a two-fold purpose in installing this new vacuum unit at its Canton, Ohio, refinery. Using as a raw product 15,000-bpsd of bottoms from a crude unit, the combination heater (left) and vacuum tower (right) will produce additional feed stock for catalytic cracking into gasoline, and large quantities of asphalt in anticipation of the federal highway program. Chemical Plants division, Blaw-Knox Co., Pittsburg, designed and constructed the unit under a contract which included 6,000-bpd catalytic reforming and hydrogen desulfurization units to increase the company's output of high octane gasoline.

Shell Oil Co. has opened a new oil blending plant at Newport, near Melbourne. It is the final unit in a five-year building program. The installation is said to be the largest distribution center for oil products in Australia.

The Newport plant covers 55 acres and can blend more than 7-million gallons of lubricating oil a year. The installation of linked directly with Shell's refinery at Geelong by a pipeline 33 miles long.

Rumania reports that capacity of its refineries at end of 1957 was 12 million tons per year of which 30 percent was gained by thermal cracking. A lube oil plant has begun production at Teleajen. The first installation for chemical treating of natural gas has been put into use, as well as the production of detergents. Another petrochemical plant is being constructed at Borzesti, where there is already a plant for plastics and one for acetylene. A synthetic rubber plant is being constructed at Onesti.

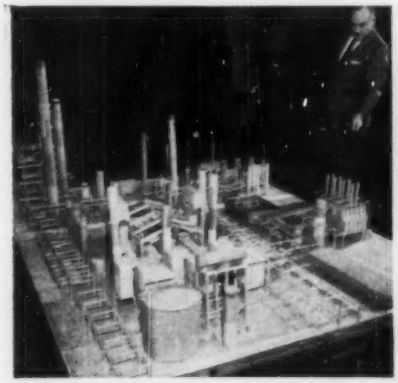
Reichhold Chemicals, Inc. has picked Kansas City, Kansas, as the site of its seventh formaldehyde producing plant in the U. S. Designed to produce 30 million pounds of formaldehyde a year, the $500,000 facility will be built in time for RCI to start production around next April.

Reichhold will ship methanol, for formaldehyde, to Kansas City in river barge loads direct from its producing point in Pensacola, Fla.

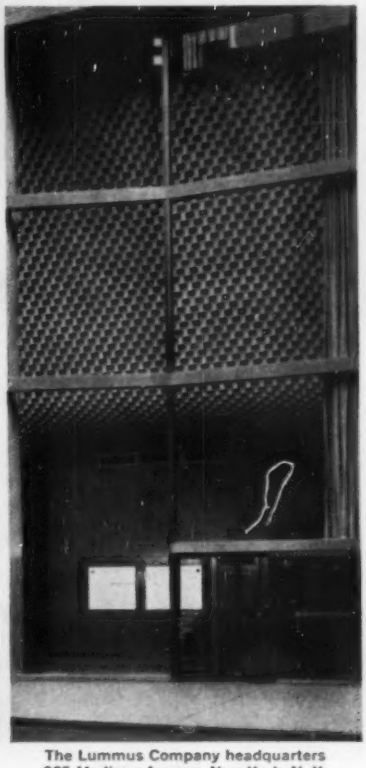
D-X Sunray Oil Co.'s catalytic cracking unit at Duncan will receive a major revamp costing about $600,000 and resulting in increased capacity and improved efficiency of the unit. Harry A. Brown, vice-president of manufacturing, said the unit shut down November 1 for an inspection and turnaround.

During the shutdown, the Refinery Engineering Co. of Tulsa will do the revamping work. One of the major changes will be the installation of a gas turbine blower. It reportedly will mark "the first

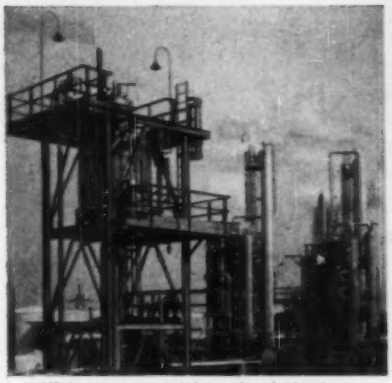
One of a series of advertisements on Lummus' world-wide facilities.



200,000,000 lb. per year ethylene plant



Beryllium plant



High pressure acetylene chemicals plant

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600 ton per day coking unit

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Engineers and Constructors of More Than 700 Refineries, Chemical and Petrochemical Plants of all Types and Sizes Throughout the World in the Last 50 years.

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In addition, Lummus maintains a 150,000 square foot Engineering Development Center in Newark, N. J., to bridge the practical gap between laboratory research findings and commercial plant operation. The Center has extensive pilot plant facilities in operation, and is equipped for designing and building new units.

Several recent domestic projects of The Lummus Company (pictured above) are: a 200,000,000 lb. per year ethylene plant; America's first full scale, high-pressure acetylene chemicals plant; a beryllium metal plant; and a 600 ton per day coking unit designed for the heaviest charge ever fed to a coker.

See Lummus on your next project.

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For more data on advertised products, use Readers' Service Cards, last page.

time in the history of the oil industry that a gas turbine blower has been used in a refinery processing unit."

The new auxiliary combustion air blower is being added to furnish additional air for increasing the coke burning capacity of the unit. The new blower will be driven by a 1,100-horsepower gas turbine.

Other work to be done includes:

- Twelve new cyclones in the regenerator for improved efficiency of catalyst recovery.
- The old cast iron trays in the cat cracker's main fractionator will be removed and modern high capacity trays installed.

Revamp of the cat cracker is being done to increase the cracking capacity of the unit and to enable the company to convert low value fuel oils into gasoline, tetramer and alkylate.

Japan Plant Association and Brazil Nitrogen Corp. are completing plans for a $13 million nitrogenous fertilizer plant in Brazil, utilizing joint Japanese-Brazilian capital and facilities, which would be the first of $100 million worth of such joint ventures. The plant would be built at Aratuhipe, Bahia state, and tentative plans call for it to manufacture 20 tons of ammonia, 180 tons of lime, 150 tons of nitric acid and 150 tons of urea daily.

Japan would supply 45 percent of the capital in the form of machinery.

E. I. duPont de Nemours & Co., long a buyer of caprolactam, has announced plans to build a 50 million-pound-a-year plant near Beaumont, Texas, in which it will make the product. The company's venture into caprolactam caps a long-term major research effort by the Explosives department. The unit will be built by the Explosives department on the company's present plant site near Beaumont.

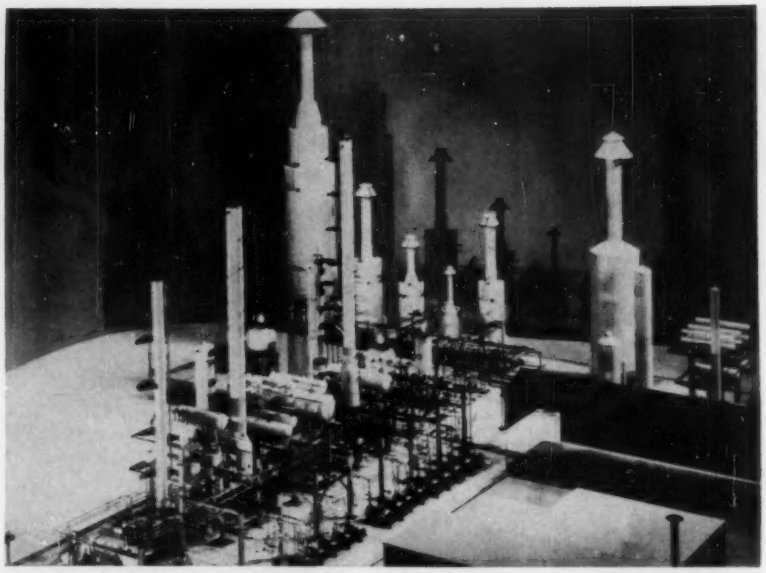
Economies in the new process are made possible by the use of low-cost petroleum derivative and technological improvements. The process will provide a co-product, cylohexylamine.

Construction will begin early next year with start-up slated for the third quarter of 1960. Design and construction work will be directed by the company's Central Engineering department.

The Soviet Union is seeking to import a large-sized phthalic anhydride manufacturing plant from Japan to meet its own demands for newly-developed synthetic textiles. The U.S.S.R. has already contacted the Kawasaki Chemical Industry Co., of Kawasaki City regarding such a plant, which Kawasaki officials say would cost in the neighborhood of $278,000.

The Japanese firm is expected to submit an estimate for the plant's construction to the Soviet Industrial Technique Import Corp. in the near future, and is working on plans for a plant with an estimated yearly output of 1,800 metric tons.

From the Soviet standpoint, this plant would serve as a pilot operation for developing its own chemical industry, since it is understood that the Russian goal is to set up sufficient phthalic anhydride plants to produce 40,000 to 50,000 metric tons yearly under its sixth five-year program.



Esso's Netherlands subsidiary has begun work on this 95,000-bpd refinery.

Esso Building $50 Million Unit at Botlek

The first piling was recently driven for a new $50 million Esso Nederland N.V. refinery in Rotterdam. When completed in 1960, capacity will be about 95,000 bpd or 4.5 million tons a year of crude oil. The refinery, to be located in Rotterdam's Botlek area, will supplement the supply from Esso's refinery in Antwerp. Principal contractor for engineering and construction of the plant is Badger-Comprimo N.V. of The Hague. It will have ample room for both crude and refined product storage, and for future expansion. The refinery will have modern waterfront facilities including piers capable of loading three supertankers at once, and loading stations for trucks and tankcars.

Esso's Powerforming process will be employed. Airfin coolers will be used throughout, promising economic operation, and elimination of water pollution problems. Processes will be electronically controlled, with possible conversion to complete automation in the future.

Gulf Oil Corp. reports that the Philippine National Economic Council has approved an application by Philippine Investment Management Consultants and Gulf to establish a $23 million oil refinery in the country. It was recommended that the Central Bank make available to the group a foreign exchange allotment of $5 million over a three-year period.

Also adopted was a "dollar-saving" financing plan which would set an absolute production ceiling on all foreign-owned refineries, including the Caltex and Stanvac refineries and the recently approved Shell refinery. According to Jose Locsin, president of the Council, the two American firms would "be limited to their 1957 sales volume." He said Shell would be authorized to refine and market its proposed capacity at 20,000 bpd.

Snia Viscosa is building a new carbon disulfide plant, reported to be Europe's largest, at Varedo, near Milan, Italy. The new facility, for which ground has been broken, will use a new carbon disulfide process developed and licensed by Food Machinery & Chemical Corp. Completion of the installation is expected in 1960, with output slated primarily for the rayon industry.

Snia now produces rayon, viscose staple fiber, synthetic yarns, polyamide fiber, plastic, pulp and machinery for textile and chemical plants.

House of Koor, head of industrial enterprises, Sole Boneh, has received authorization to build a plant on the Bay of Haiffa for production of 25,000 tons per year of lubricants, asphalt and other products, according to ESSO patents. The new unit will cost $8 million, of which the Koor group and the U. S. will carry the expense—the balance will be furnished by development of Israelian industrial credit.

Shell Oil Co. plans to build a natural gas processing and cycling plant at Weeks Island field in Louisiana. The new 120 MMcf per day installation will recover hydrocarbons, such as propane and butane, and return the gas to the producing formation.

Carbometal, an Argentina firm, plans a vast program of industrial expansion in Mendoza province in association with foreign interests, including:

- Monsanto Chemical Corp., which will set up Monsanto-Andes with annual output of 4,500 tons polyvinyl chloride, 200 tons acetylene, 2,000 tons chlorine, 7,500 tons plastics and 6,000 tons salt. This production will save Argentina an estimated $4 million in foreign exchange.
- Norton Co. will set up Norton-Casale, to produce 5,000 tons abrasives, 10,000

Circular sidewall of B&W Insulating Firebrick in an oil heater

How B&W Insulating Firebrick cut processing costs

Here are four *key* reasons why B&W Insulating Firebrick reduce over-all costs in chemical and petroleum process furnaces:

High Hot Load Strength —B&W IFB provide maximum load-bearing capacity *under operating temperatures.* Many oil heaters have been built with walls 80 feet high *with no intermediate support.*

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Long Life — B&W Insulating Firebrick are *long* lasting because of the exceptional refractory nature of their base ingredients and the high processing temperatures to which they are subjected during manufacturing.

Short Installation Time —You save materially with B&W Insulating Firebrick because they are machined to size. They may be modified to fit door openings, peepholes, and other special conditions because they can be cut, drilled or shaped on the job with ordinary woodworking tools.

These sound reasons explain why process furnace builders and operators specify B&W Insulating Firebrick. Learn how these lightweight brick can help you save money. Your B&W representative will be glad to give you facts and figures.

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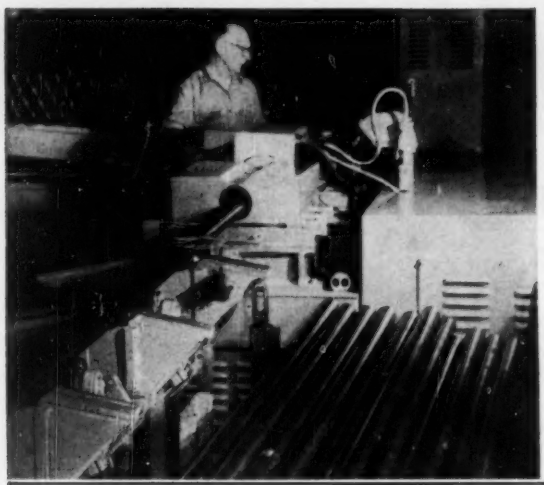
QUALITY YOU CAN MEASURE

Republic ELECTRUNITE Heat Exchanger Tubing



Quality is controlled! Republic ELECTRUNITE® Heat Exchanger Tubing is produced by one integrated, responsible producer—Republic—who controls quality from mine, through mill, to finished product.

Quality is built-in! ELECTRUNITE is formed from highest quality flat-rolled open-hearth steel and "electrically-welded" by the exclusive ELECTRUNITE process that unites the tube under pressure without the addition of foreign or extra metal.

Quality you can see! ELECTRUNITE is uniform in wall thickness, diameter, concentricity, strength, weight, surface finish. All reasons why ELECTRUNITE Heat Exchanger Tubes slide in easily, expand evenly, roll-in and bead over quickly, meet critical performance specifications.

To learn more about the cost saving performance advantages of ELECTRUNITE, call your Republic representative, or write direct.

Wall Thickness	Minor Dimension of the Defect (Length or Depth)	Length X Depth Area in Square Inches
20 ga.	.006"	.0025"
18 ga.	.006"	.003"
16 ga.	12½% of Wall	.003"
14 and 13 ga.	12½% of Wall	.004"
12 ga. and heavier	12½% of Wall	.005"

FARROWTEST detects and rejects defects completely penetrating tube wall, or equal to, or greater than, those shown in this table. Where required, sensitivity of FARROWTEST equipment can be calibrated to reject defects of lesser specified area than shown in table, at extra cost.

QUALITY YOU CAN MEASURE — FARROWTEST® Not a laboratory theory, not a mere inspection tool, but an exclusive production test that detects and rejects defects of critical size. The additional quality protection of exclusive FARROWTEST is offered as an alternative to other less positive tests . . . at no extra cost.

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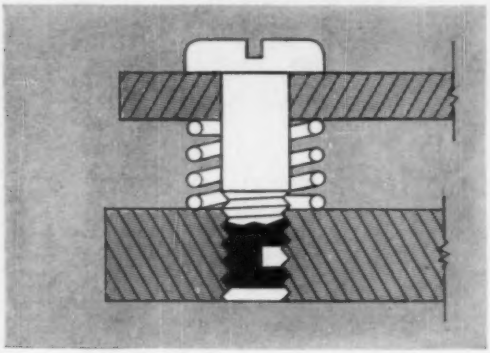

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For more data on advertised products, use Readers' Service Cards, last page.

Who's Building...

tons refractory bricks and 500 tons emery paper.

Carbometal also plans to make calcium cyanamide, melamine and urea in conjunction with a German company.

Shell Oil Co.'s West German subsidiary has opened a new $56 million refinery with an annual throughput of two million tons. Two supertankers can discharge crude at the same time at the refinery's quay. Shell is to open another refinery near Cologne in the Summer of 1960.

The president of the West German Industries Association, Fritz Berg, said that the Western European oil industry intended to "double its refining capacity." At present, capacity within the six common market countries is 95 million tons a year compared with 450 million in the U. S.

Argentina is negotiating with 15 firms or groups in Argentina for installation of a reforming plant capable of producing 1,000 cubic meters of naphtha daily. The plant will be added to the San Lorenzo distillery in Santa Fe province, which currently refines 2,000 cubic meters a day. Another bid has been opened for construction of a plant to produce up to 120,000 cubic meters of lubricants yearly—also an extension of the San Lorenzo establishment.

Japan Synthetic Co. has begun construction on a plant capable of producing 30,000 tons of synthetic rubber annually at the initial stage. One half of the company's capital has been invested by the government.

The plant which will be completed by October, 1959, will produce 35,000 tons in 1961, 40,000 tons in 1962 and 45,000 tons in 1963.

The company has contracts with four American firms, including Goodyear Rubber Co., for technical assistance and plans to import equipment from the U. S. and Switzerland.

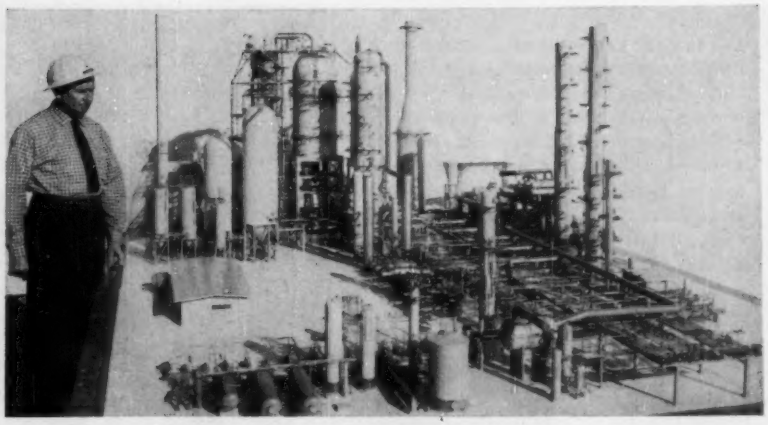
Compagnie Pour la Fabrication des Compteurs et Materiel Dusines a Gaz and its two affiliates, Compagnie Generale de Construction de Fours and Societe de Construction d'Appareils Pour le Gaz a l'Eau, have won a $2.2 million contract to build a gas plant and gas distribution network at Marianao, a suburb of Havana, Cuba.

The gas works will include a fuel oil catalytic cracking unit.

The contract was concluded with the Compania de Servicios Metropolitanos de Gas which had secured the support of the Cuban Bank of Industrial Development.

Runnels Gas Products Corp. and Texas Gas Exploration Corp. are increasing capacity of their Eunice, La., gasoline plant by 69 MMcf of gas per day. A $500,000 contract has been awarded The Fluor Corp. for construction. Engineering work has begun on the project, which is slated for completion in April, 1959.

Snam-Progetto, the Milanese Company, is going to construct a refinery and a pipeline in Jordan, expected to be built within 3 years at a cost of $10-$12 million.



StanCal Breaks Ground for Hawaiian Plant

This model of the fluid catalytic cracking unit for Standard Oil Co. of Calif.'s new 32,000-bpd Hawaiian refinery was put on display in Honolulu October 24 just after groundbreaking ceremonies for the new plant at Barber's Point, 22 miles west of town. The multi-million dollar refinery will be built on land just west of the Barber's Point Naval Air Station. Two hundred acres have been purchased from the Campbell Estate and 100 acres leased to provide for possible future expansion.

The plant will manufacture gasolines, jet and diesel fuels, asphalts, liquefied petroleum gas and residual fuels for industrial use. Crude oil will be delivered through a submarine offshore pipeline.

Esso Standard, Paraguay plans to construct, operate and finance a 3,000-bpd refinery near Asuncion, Paraguay. Upon government approval, construction would begin immediately, with completion at the end of next year.

Cia. Copetroleo, the Cuban firm, is planning a $25 million, 18,000-bpd refinery at Nuevitas, Camaguey province, to refine Venezuelan crude. The company will export 75 percent of its production.

Westcoast Transmission Co., Ltd., has received permission from the Alberta government to purchase land just west of Coleman for a gas processing plant. Construction on the $15 million plant will begin when Westcoast receives permission to export Alberta gas.

Poland foresees refining 160,000 bpd of Soviet crude by 1975, under a government plan to build a Soviet-sponsored refinery. The plan includes a 40,000-bpd initial capacity by 1964, with increases to come in stages. No location for the plant has been released.

ERRATA

In the article "Heat Transfer Nomographs," October, page 131, the example showing use of Figure 1 gives an answer of 1150 ft./second. This is a typographical error. Actually, the answer should be 150 ft./second.

In the article "Pressure Drop Through Bubble Caps", Page 127, August, 1958, the name of Dr. Ju Chin Chu, of the Polytechnic Institute of Brooklyn, was inadvertently omitted. Dr. Chu co-authored this article with H. T. Welch.

Hercules Powder Co.'s 20,000 ton per caprolactam monomer facilities at Hopewell, Va., sometime next month. The plant's capacity will be upped to 60 million pounds per year.

New England Gas & Electric Association, Cambridge, Mass., plans to enter active petrochemical production. Tentative plans call for a refinery to be built on land purchased from New Bedford Gas & Edison Light Co., a company subsidiary, which would also supply natural gas for production of butadiene, propylene and tars. Negotiations for the move are well advanced.

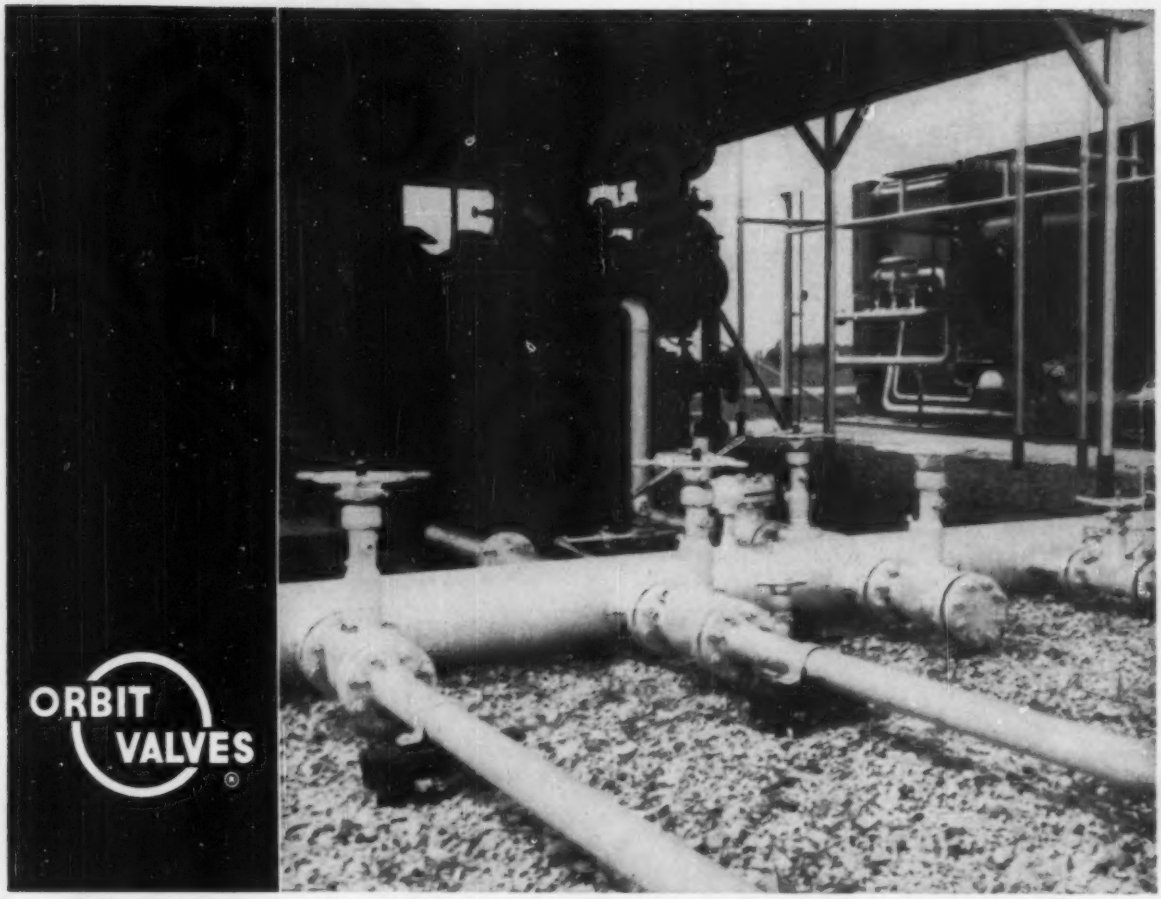
China Artificial Fiber Corp. has begun construction of a new viscose staple unit to add to its production of viscose filament. The plant will manufacture 10 million pounds per year. Von Kohorn International Corp. will supply engineering and machinery for the project.

Hercules Powder Co.'s 20,000 ton per year urea plant at Hercules, Calif., has gone on stream. About 75 percent of the production will go into high-nitrogen liquid fertilizers. The balance will be used for urea-formaldehyde resins for the plywood and particle board industry.

East Germany has begun preparatory engineering on a large refinery near the terminal of the Russian-East German pipeline, through which the U.S.S.R. estimates 100,000 bpd will be pumped by 1965. East Germany reports that this plant will initiate large-scale petrochemical operations there.

Shell Chemical Corp. (Australia) is planning an epoxy resin plant near Sydney, Australia. The $1.5 million unit is slated for completion in 1960, and capacity will reportedly be "sufficient for the entire Australian demand."

QUALITY AND RELIABILITY AT WORK



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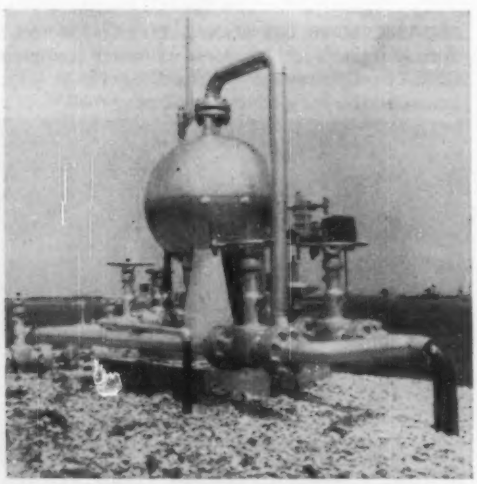
and built for continuous heavy-duty service



Orbit valves shown in picture at top are installed in compressor discharge service. This is a tough service where velocities and vibration would play havoc with most valves — but not with Orbit valves, because they are built to withstand continuous heavy-duty service.

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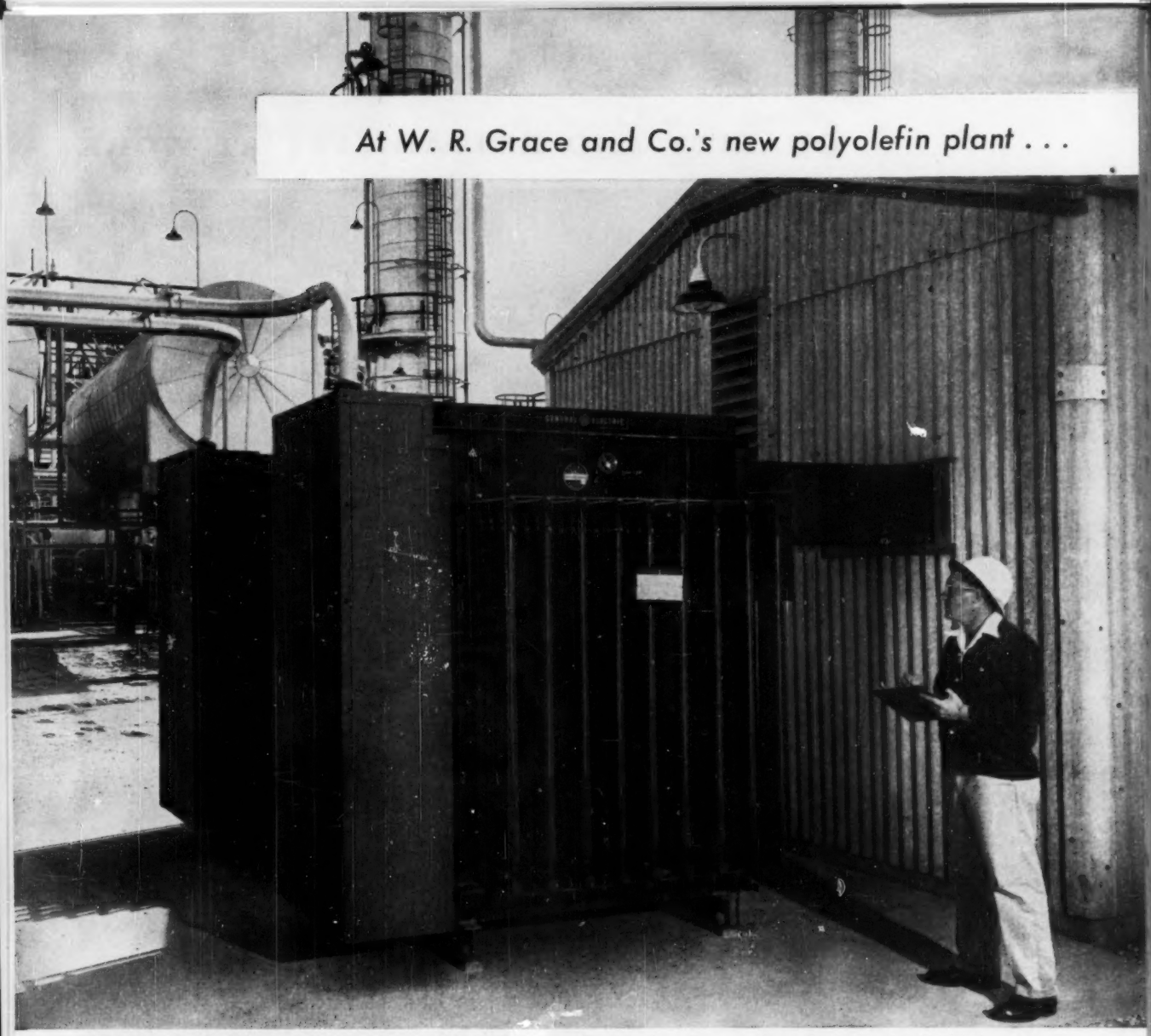
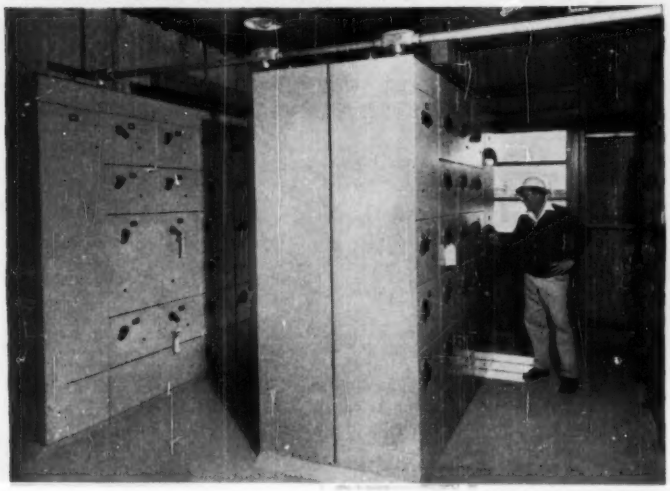
At W. R. Grace and Co.'s new polyolefin plant . . .



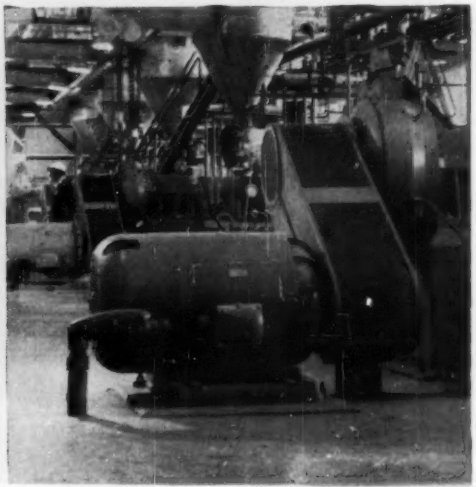
RELIABLE G-E TRANSFORMERS are easy to install, easy to maintain. Transformers pictured are rated 1,000-KVA.

PRE-ASSEMBLED, PACKAGED nature of General Electric motor-control centers greatly reduced installation costs at new Grace and Co. polyolefin plant. Equipment costs were less because remotely located centers did not require extra-protected equipment.



RELIABLE, LONG LIFE General Electric 150-hp induction motors drive extruders which compress GREX† pellets in their final form.

† Registered Trade-mark of W. R. Grace and Co.



Standardization on General Electric equipment cut spare parts inventory by 60%

Here's how single-source purchasing and expert system-engineering assistance cut installation time and costs, and saved valuable floor space for the Polymer Chemicals Division of W. R. Grace and Co.

Because standardization on General Electric motors, controls and switchgear permitted maximum parts interchangeability, W. R. Grace and Co. reduced anticipated spare parts inventories by 60 per cent at their new Baton Rouge polyolefin plant. Now, spare parts for their entire electrical system occupy less than 1 per cent of their warehouse area, making valuable space available for production items.

In addition, G-E engineering know-how and system-engineered electrical products helped cut installation time and costs at this new 50 million pound petrochemical facility

Unit responsibility is the key to these major reductions. Because of the many and varied applications in this plant, W. R. Grace and Co. officials felt that standardization on one supplier was the most efficient and economical way to do the job. Previous experience with G-E equipment and technical assistance encouraged their choice of General Electric.

The pre-assembled, complete-packaged nature of G-E substations, switchgear and motor-control centers greatly reduced installation costs at this W. R. Grace and Co. plant. The remote location of the control equipment—made possible by the principle of the motor-control center—eliminated the need for expensive, specially-protected equipment.

Over 300 rugged G-E induction motors, ranging from fractionals to 150-hp, are spotted throughout the 30-acre site to provide the power required to keep the plant running 24 hours-a-day. These extra-protected motors drive pumps, agitators, extruders, mixers, conveyors and rotary valves. Built for longer life, even under tough refinery conditions, these G-E motors require less maintenance, keep downtime to a minimum.

If you plan to build a new plant, or expand your present facilities, General Electric offers the system-engineered equipment and the technical assistance to provide you with an economical, efficient electrical system. Contact your nearest General Electric Apparatus Sales Office for complete information. General Electric Company, Schenectady 5, New York.

681-16

Engineered Electrical Systems for the Petrochemical Industry

GENERAL ELECTRIC

FOR GREATER MAINTENANCE FLEXIBILITY, G-E AK-25 air circuit breakers can shut off small parts of plant when repairmen are at work. 1200-amp breakers are also used as large motor starters.

RUGGED TOTALLY-ENCLOSED and explosion-proof G-E Tri-Clad* '55' motors provide extra protection and greater safety required for some refinery applications. More reliable Tri-Clad motors require less maintenance, reduce system shutdowns.

*Reg. Trade-mark of General Electric Co.

Warren concentrates its efforts to bring you...*DEPENDABLE DELIVERIES OF*

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The Engineer and His Two Friends

The computer and the general-purpose program are looming as bright stars on the engineer's horizon. Here's how all three can work together as a team

E. P. Bartkus and W. M. Carlson
E. I. du Pont de Nemours & Company, Inc., Wilmington, Del.

INDUSTRY is at the threshold of what could become another industrial revolution.

What is the tool bringing about this impending change? We think it is the high-speed electronic computer! These computers are extending the frontiers of our mental powers, just as the Industrial Revolution opened frontiers for our physical powers.

These new powers are bringing about new approaches, not only to research and development, but to plant design, to operation, to product finishing and product sales. Computers are already playing an essential role in selecting a particular process and in optimizing product distribution for some chemical and petroleum companies.

Entirely Different. A few scouting parties out on this new frontier say they generally find two engineers struggling with computers. First, there are the engineers who are craftsmen —full of empirical rules of their craft and suspicious of mechanized innovations.

Secondly, there are the engineers who sense a need for new tools to breach technical frontiers and who hope computers are going to supply part of the new tools needed.

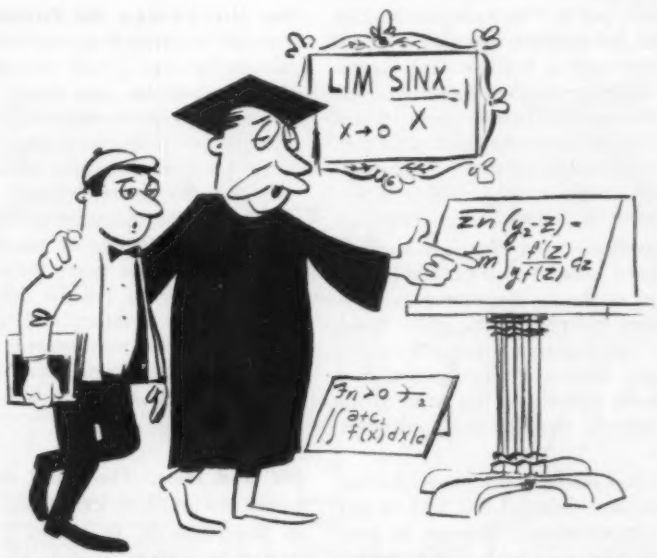
Three major questions crop up because of this tug-of-war:

1. Why has the engineer in the chemical industry had to resort to empirical judgment to such a large extent?

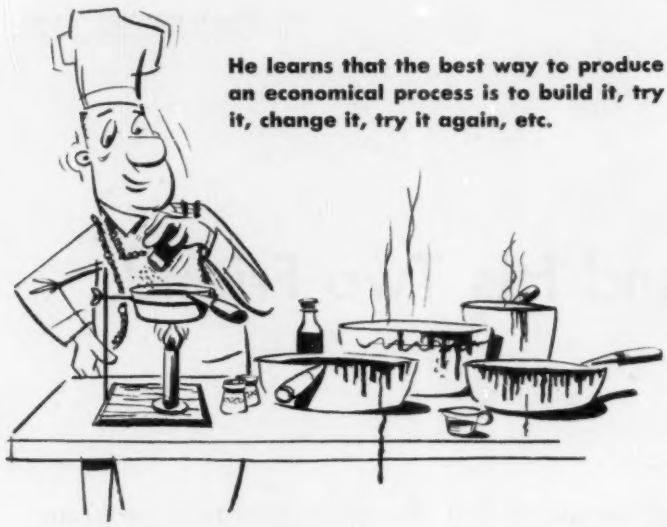
2. Why are computers forcing the scientific approach on the engineer?

3. Why should some agency undertake to correlate, and disseminate, general purpose programs which will accelerate effective use of computers?

Before covering these questions, though, you should be reminded that



"In most colleges, undergraduates go on a guided tour of an impressive museum of theorems."



He learns that the best way to produce an economical process is to build it, try it, change it, try it again, etc.

the computer must be considered as just a tool that the engineer has to manipulate in solution of his problems. The most expensive part of the computer picture, in the larger companies at least, is the engineer who makes the technical decisions. Also, this article will deal exclusively with digital computers and not with analog machines.

The Engineer: His Training. Most engineers were exposed to a substantial number of mathematical courses in college. Although perhaps this presentation was somewhat sterile.

As one practitioner, Professor Zdenek Kopal, University of Manchester, put it, "In most universities, undergraduates are taken on a guided tour through a brilliant and impressive museum display of theorems and corollaries—brilliant to behold and admire, but not to be touched in their time-honored showcases." To most engineers, then, mathematics is like Latin—it is almost a dead language.

Specifically, the chemical engineer has been trained to translate, by empirical methods, the discoveries of chemists and physicists into the "hardware" of a manufacturing facility. Because his mathematics had been generally limited, he has adopted lots of "rules of thumb" and approximations.

He has learned, both in school and in practice, that the best way to produce an economical process, or piece of equipment, is to build something, try it, change it, try it again, make it bigger, or smaller, or wider, and so on to further improvements, as long as there is sound economic motivation to keep going. Therefore, his education has been devoted to devising and using sets of empirical equations which "correlate" his observations with plausible accuracy and provide a basis for extrapolation within modest limits.

The culmination of this training is the creation of highly specialized men (and their techniques) who can, with the minimum amount of experimental data, provide design specifications for a unit that will work, whether it be a heat exchanger or a whole plant.

The Unknowns He Faces. The chemical engineer is at a severe disadvantage in dealing with the phenomena for which he must design. There are too many interacting variables for them to be correlated in the human mind. He does not know what really goes on inside of the reactor; he has never seen one molecule collide with another to form one or more other molecules. He has never seen a discrete molecule of liquid decide it wanted to be a vapor, and to leave behind it its less venturesome brothers. Neither has anyone else, and no one has ever devised tools with which to observe these events.

Hit and Miss. The world that the engineer works with treats these events in their over-all, or statistical sense. It has been only recently that adequate effort has been made to catalog all of the factors that influence the statistical behavior of our chemical and physical processes. Up to now, the effort has been to "guess" which two, or three, or four factors have the most effect, and produce empirical expressions which approximate the observed results. Appreciation of the interrelation of the various significant factors has ofttimes been a hit-or-miss proposition.

To be more specific, some chemical combinations appear to occur at the rate of 10^{-3} to 10^{-7} seconds. With today's instruments, however, we can only approach the desired measurements to the extent of 10^{-1} to 10^{-2} seconds. But, generally, the engineer with his current approaches, designs for 10^{-1} to 10^{+2} seconds. Yet, this approach has permitted the engineer to go ahead and do a good (usually a creditable and often spectacular) job without ever really "knowing" what went on in a fundamental, or mathematical sense.

The Approaches He Takes. The bulk of an engineer's effort is spent in collecting and correlating data. One of the obvious and also one of the simplest methods for beginning a study of data, is to plot one variable against the other on graph paper. From these plots, an engineer seeks general trends.

When a trend is found, he expresses these trends with smooth curves. One of his big difficulties, of course, is that this feeling for the geometry of the problem leaves the engineer when he has more than two variables.

Someone else has summarized the situation in words that bear repeating. An engineer will rarely set up a problem in a form which is beyond his personal ability to solve, and we submit that it is this restriction which offers the largest obstacle to progress. Let's pause and take a look at how the engineer keeps his problem simple.

Fitting the Picture. Since the chemical engineer lacks formal training in statistical methods, or the calculus of rate processes which describe events as they actually occur, he resorts to "snapshot" techniques.

In this method he essentially cuts out a static picture of an operation at some particular or "average" moment.

He changes one variable at a time

"What the chemical engineer does with the opportunities he now has may determine the future of his profession . . . for he who realizes he can formulate problems larger than he can solve, will lead the procession."

in a lengthy, costly experimental program. He learns the general effect. He allows a good margin for error and for other unknowns. He then constructs a mathematical picture of the operation to see if it fits the "snapshot." If it doesn't, he keeps adjusting his computed model until it does fit.

When a particular equation, or set of equations, fits a broad range of "snapshots," the equations are published and become an established engineering tool, containing at times paradoxical assumptions.

Today, and in the future, however, when the engineer designs a process or equipment unit, the "snapshot" perhaps can be a film strip covering conditions which are non-equilibrium or dynamic. He will be able to do this with new tools, among which are the computers.

The Help He Needs. The chemical engineer needs help: from applied mathematics, from operational statistics, from computers. He needs to absorb some of this himself; but perhaps much more important, he needs to recognize the need and the source for this specialized assistance. It is expected, of course, that the engineer will recognize the problem and state it orally.

Depending on his individual talents, he will require some help in formulation of the problem, programming, computer solution, and analysis. In any one step to problem solution and acceptance, the engineer's participation may run from 100 percent to 0 percent, while that of the individuals of his team may be from 0 percent to something less than 100 percent.

The chemical engineer did not recognize the need for this help at the industrial level until the last five years or so; and the need is just beginning to be appreciated at the college level.

Where the engineer has been teamed with the statistician and/or the applied mathematician; backed up by computers to work out the complex problem statements that result, the benefits have been highly rewarding both technically and financially. There have been rare instances where the same man combined the talents of engineer, mathematician and computer programmer—the ideal situation. So, until the basic training of the engineer changes to fit the impending needs, a mixed team approach must be counted on.

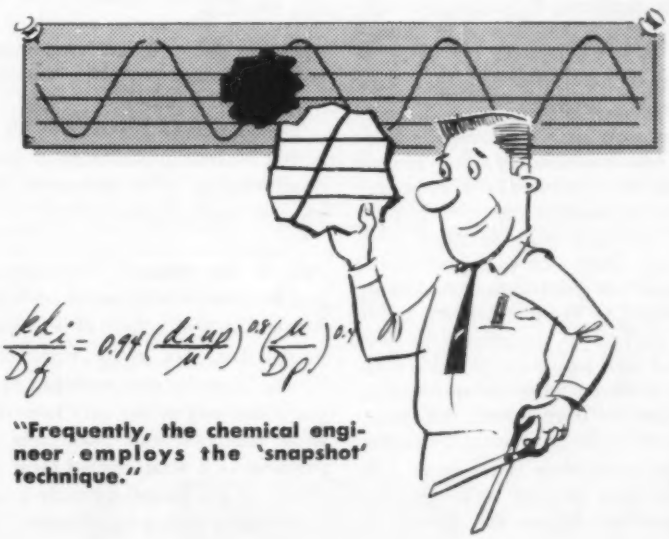
However, the engineer is still the focus point in developing a solution to a problem. Under no circumstances should the engineer turn over to the mathematician, the statistician, or programmer, the full responsibility for defining the problem and for determining the acceptability of the solutions. That must continue to be the engineeer's responsibility.

The Opportunities Ahead. Today, with machines that can compute at phenomenal speeds, a fresh look at engineering rules of thumb is necessary. What has been considered a necessary simplification of the solution method heretofore, can now be considered an unnecessary oversimplification. Mathematicians, in doing their part to help the engineer, are developing new methods of attack on old, unsolved problems. The engineer in the chemical industry cannot afford to bypass them.

What the chemical engineer does with the opportunities he now has may determine the future of his profession. The successful engineer of the future will be the man who interprets the know-how of the chemists into hardware; he will be the man who uses fundamental physical and mathematical principles to explain what the chemist observes. The very act of trying to develop these scientific explanations will produce tremendous powers of prediction for the engineer.

The chemical engineer also has a personal opportunity. The man who realizes he can formulate problems larger than the ones he can solve, is the man who will lead the procession. The tools for solving these larger problems are at hand and ready for use. To use them, though, the engineer must be able to write down explicitly what he does in solving a problem. This is so others who are to help him will know exactly what he is thinking, and exactly what he wants.

The Vanishing Breed. In approaching the computer, the first thing that the engineeer encounters is the organization that surrounds it. The computer has come crashing into American industry in such a well-developed state that the assumption has been made that a new profession must be



"Frequently, the chemical engineer employs the 'snapshot' technique."

"The engineer must be able to write a set of computer instructions that will solve a broad range of particular problems. Here lies the answer which brings the engineer and the computer together—the general-purpose program."

created to make effective use of it—this is the profession of programmers.

The truth is, there is no permanent need for such a profession which, at present, solves problems for other professions. When engineers learn to instruct computers to solve their own problems and when the coding requirements are simplified, the need for the programming profession will vanish.

It may not be stretching a point to observe what happened to the last great profession which translated human messages into machine language. They were known as telegraph and wireless operators. Therefore, we have to look at the organizations that have grown up around computers in some of our companies as organisms in transition—an evolutionary step toward something more stable.

Today, the engineer must deal with three hurdles surrounding the computer. First, there are the analysts—the people who understand the vast technical potential of computers and who have the math and statistics to exploit the potential. Second, there are the coders—those who instruct the machine. Third, there are the operators—the people who run and maintain the machine and the people who schedule its use.

Who Are Analysts? Today, many analysts are trained and oriented in mathematics. This knowledge allows them to converse with the machine somewhat more efficiently than their engineering brethren.

Tomorrow, it is expected the engineer will have upgraded himself enough technically to be able to formulate and analyze the problem himself. Then after using automatic coding, will leave the sub-professional mechanics of putting the problem on the computer to the computer operations staff. The engineers who have worked their way through to the computer at the center of the surrounding organization have found out something about the procedures it enforces.

The computer is a severe taskmaster. The average engineer just automatically knows the answers he desires should be accurate only within a certain tolerance, often as much as ± 25 percent. He, therefore, doesn't understand why the machine needs such excruciating detail about the problem before it can produce answers. More importantly, he refuses to believe that he must be absolutely accurate about every statement he makes or number he uses.

Memory and Speed. It must be expected that there is a vast difference between the procedures the engineer and the computer use in solving a problem once it is formulated. The engineer has 10^4 times the storage, and 10^{-4} the speed of the computer. Further, the engineer's techniques are some unexplainable mixture of analog and digital procedures. Today's computer is either analog or digital, but not both. Also, the engineer (with a dictionary) has a language utility of 10^4 times more words than the computer can act on. In the light of these discrepancies of four orders of magnitude, it is not difficult to see why the engineer finds the accuracy and detail requirements of the computer hard to comprehend.

All this means the machines are forcing problems into their own restricted language and in a form that permits them to be efficient. As long as this continues, the engineer can get his problem across to the computer only if he knows enough so that he can translate it into unambiguous terms. He must translate "intuition" into precise definition.

The engineer's reaction to all this is that he feels bound in strait jackets when dealing with computers. Let's examine some of these jackets.

"Do It My Way." The computer and the people who surround it have fostered an atmosphere of self-perpetuation that says to the engineer, in effect, "You do your problems in this particular way or we can't help you!" Most engineers look upon this constriction as a strait jacket, and they refuse to get mixed up with a computer under such a set of rules.

In some organizations, this has been answered by having each engineer's problem handled as a one-shot problem.

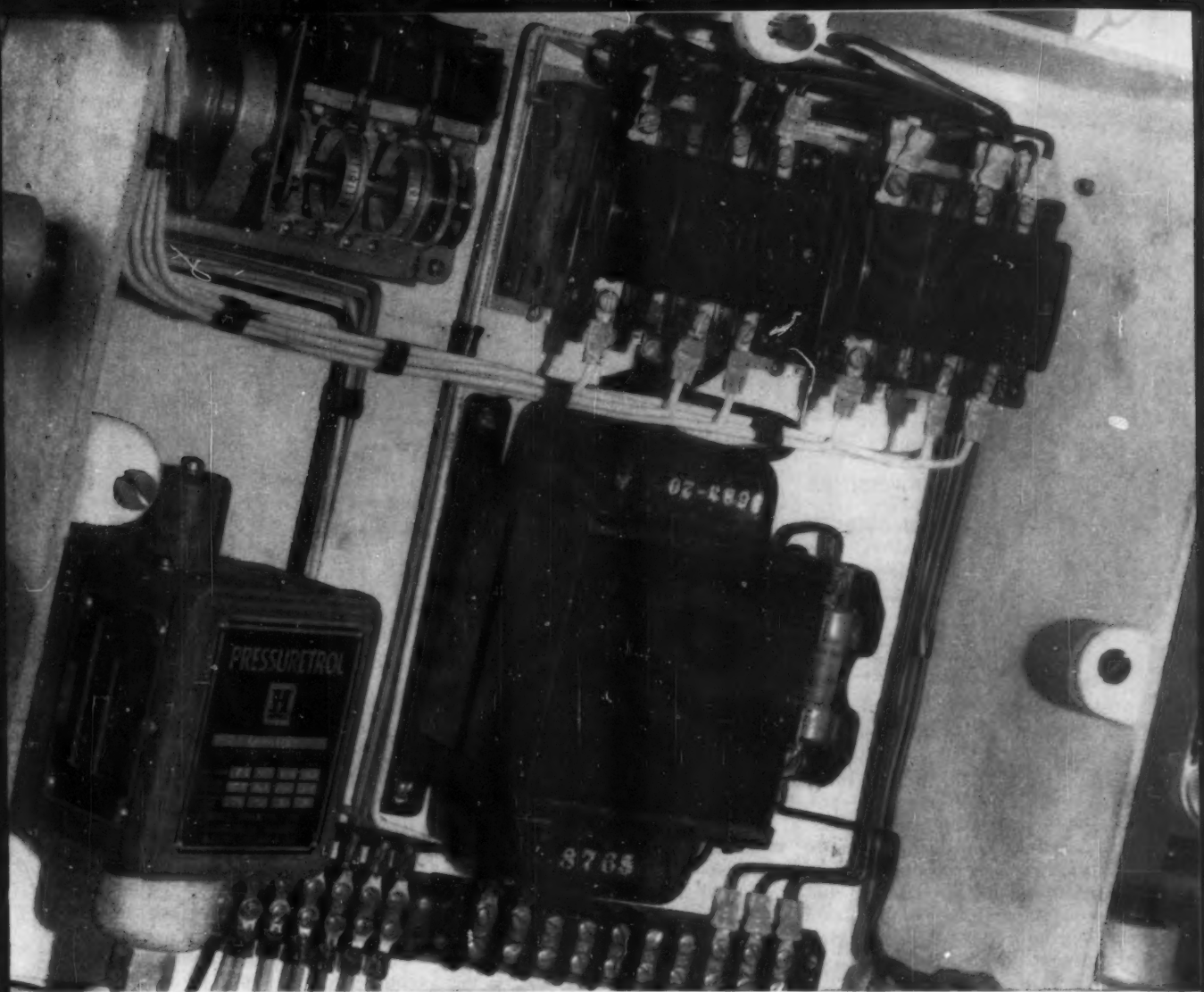
This immediately produces another kind of strait jacket—there just aren't enough analysts and coders available when the engineer needs help the most.

In another approach, the problem has been answered by following the trail blazed by the mathematicians and scientists. This is, to write a set of computer instructions that will solve a broad range of a particular class of engineering problems. The engineer simply fills in a data sheet and takes it directly to the computer. He doesn't wait on someone else to help him. Herein lies the answer which brings the computer and the engineer together—the general-purpose program.

A Broad Basis. The general purpose program, by its very name, implies that the persons who write it will be able to think of all contingencies and provide a basis for handling each one. Such a goal is almost unattainable, but many programs now exist that come surprisingly close.

A good general purpose program will often require six months of careful analysis to define the problem in a clear verbal statement, to select the range of conditions to be covered, and to organize the mathematical methods to be employed. From this point, flow charting and coding the computer statement can go quite fast if the engineering analysis has been sound and comprehensive. It was under these circumstances that DuPont was able to have a program in production a little over two months after the mathematical analysis was complete.

This preparation is a job to be controlled by those engineers who are going to be using the computed solutions. When these men participate only superficially in the program development, the result is easy to predict—an unsatisfactory program. The resulting problem will then require a series of revisions (and often complete



For "set it and forget it" gas drying—

Come to Kemp

Kemp Dryer protects instrument lines at −25° for Quaker State's Farmer's Valley, Pa. plant. Fully automatic operation saves time and manpower, yet provides dependable service on a 24 hour basis.

Here's the nerve center of every Kemp Fully Automatic Gas Drying Unit. Drying process gasses and inerts . . . air for pneumatic instruments and tools . . . liquids . . . for pressurizing anhydrous liquids . . . this panel controls the Kemp Dryer surely and safely. Once timed to meet your program, it provides efficient drying on a continuous basis, without worry or excessive maintenance.

Note the precision with which even the wiring is connected. It's typical of the thorough workmanship going into every component of the Kemp Dryer. Kemp Dryers are built with care; built to last and perform year after year with dependability resulting from a quarter century's experience.

Whether your operation calls for a completely automatic Kemp Dryer, a semi-automatic model, or a simple, manually operated unit, there's a model and capacity to meet your needs. Kemp Field Engineers will gladly study your problem and make complete recommendations, even down to the proper desiccant (we select from over 20) to do your job best.

Call in your Kemp Representative when you plan a new installation or wish to up-date an old one. He'll give you full information. Or write direct and ask for Bulletin D-102: THE C. M. KEMP MFG. CO., 405 E. Oliver Street, Baltimore 2, Maryland.

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Organizations surveyed in relation to their general purpose programs.

rewriting) before it will handle the problems.

However, should the engineer outline the scope of the program, evaluate its feasibility, and provide technical know-how during the mathematical and programming phases, the result will be an effective, cost-reducing, general-purpose program the engineer can use to do better engineering.

Cost Factors. The general-purpose program is inherently expensive. In addition to a whole range of conditions, it must have a well-designed input procedure understandable to the average engineer. It must also have a useful output the engineer can use readily in the next phase of his work.

On the basis of the 20 such programs that du Pont's Engineering department has in operation or under development, we are able to draw some conclusions about the cost of doing business this way.

To develop a program for calculating stresses, moments, forces, and rotations in piping systems, we have spent more than $50,000; other companies have told us they have spent up to twice this sum for their own program. Our distillation program has already cost us nearly $50,000, and we have a long way to go to satisfy our engineers' wishes for complete generality.

A new program recently completed for balancing pressure drop in complex piping systems cost $20,000 for the first application. Even a simple orifice design that takes 30 seconds of computer time required $5,000 to program in general form with adequate input and output.

A very large fraction of these costs goes into the engineering analysis. The cost of writing the code can be a pretty small part of the total if the engineering work has been done properly first.

Reaping the Harvest. Now here is the other side of the coin—the benefits. The repeated uses of a good general-purpose program can build up a fast return.

The pipe stress program, in six months of use, has saved $104,000 in design salaries and an estimated $10,000 in piping investment. You will recall it cost $50,000.

The distillation program, still in development stages, has saved $3,000 in design salaries and a minimum of $60,000 in operating costs on two plants. It has paid us back already.

The pressure distribution program, used once in a semi-developed stage, has saved $68,000 in plant investment. Needless to say, we rushed this program to completion to broaden its use.

The orifice design program has been used 400 times in six months and has saved $8,000 in salaries, or 1.6 times its cost.

There are several reasons for these savings:

1. Calculations formerly done by hand are done at less cost.

2. Calculations not attempted previously because of time restrictions are now being performed with the aid of machines.

3. Engineers with minimum experience are using the most advanced technology in their routine work.

4. Project schedules are being accelerated.

In other words, financial results come from three main sources:

1. More engineering work for a dollar of salary.

2. Lower final investment or operating cost, or both.

3. Earlier realization of profits from a new venture of capacity increase.

Looking at Others. This experience inspired Du Pont to make a survey of other organizations in the U. S. to see what they were doing with general-purpose programs. Here are the people we called.

About one-third of the calls were followed with personal visits to obtain more information. Concentration was centered at the industrial level on process industries in order to compare Du Pont's experience with that of similar organizations. The selection of the organizations was made on the basis that if an outfit was recommended by two others it was worth talking to.

Now, as to the acceptability of what is available. Virtually all engineering library programs circulated by the computer manufacturers are not usable. They lack flow charts, the writeups are prepared for the mathematician-programmer and not for the engineer, and the local coding or housekeeping conventions are neither explained nor removed before the routines are passed on to the unwary recipient.

Some Are Better. Users organizations, particularly for the smaller computers appear to have a somewhat better grasp of the engineer's neeeds. Thirty engineering routines look

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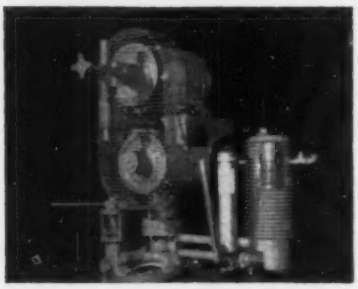


Neat compact W Drive packs a lot of power at low cost

Here's a compact, inexpensive drive that delivers up to 10 horsepower.

It's pedestal mounted so you'll find it readily adaptable to any tank, even including open vessels. It normally has a Glasteel impeller, so it's ideal for work with all corrosives. Alloy impellers and turbines also available.

Carries heavier loads. Both gear and pinion are throated, a design which gives maximum contact area to teeth —much more than with other worm drives. This translates into heavier load capacity.

Requires little attention. Maintenance on the W Drive consists almost entirely of periodic lubrication and an occasional check of alignment.

SPEED RANGE WITH VARIABLE SPEED SHEAVES

Drive Ratio	2.5W		3W	
	HP at Max. Speed	Agit. RPM Range	HP at Max. Speed	Agit. RPM Range
5:1	2	600 to 128	3	600 to 128
10:1	2	300 to 64	3	300 to 64
20:1	2	150 to 33	3	150 to 33
30:1	1.5	100 to 22	2	100 to 22

Note: There are 4W and 5W drives which deliver 7.5 and 10 HP respectively in comparable speed ranges.

Many modifications. Use stuffing box or mechanical seal. Fixed speed or variable speed sheaves are standard. You can specify hydraulic, explosion-proof design. Or, double reduction gearing and flange-mounted motor.

For more details on the W Drive, send for Bulletin 965.

More thermal shock data on new GLASTEEL 59

#53 Glass Glasteel 59

As another example of the increased thermal shock resistance of our new Glasteel 59, we ran this laboratory test:

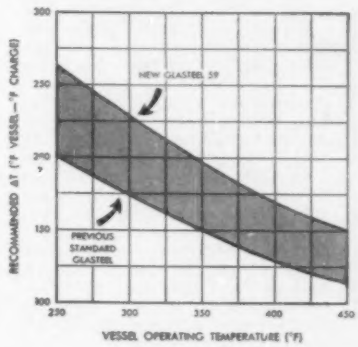
We glassed the outer convex surface of two 2-inch steel pipes, one with Glasteel 59 and one with our best previous material, #53 Glass.

Then we heated both to 525°F. and quenched them quickly in a 70°F. water bath. You can see what happened to #53 Glass (above, left). Glasteel 59 didn't show a sign of damage . . . in spite of a 455°F. instantaneous temperature change.

In other tests we heated the Glasteel 59 to 600°F.—a 530°F. △T—and even to 625°F.—a startling 555°F. △T. Still no sign of cracking or crazing or other damage on the Glasteel 59 test piece.

Naturally we do not recommend or suggest such severe treatment with your process equipment. Our point is this—with Glasteel 59, and only this glassed steel, can you have so high a degree of thermal shock protection. A full 30% increase over our previous best grade, as shown in chart below.

Thermal shock resistance is not the only property of Glasteel 59 that shows improvement. It gives you 20% better abrasion resistance and extended service life, too. If you'd like to know more about our complete line of Glasteel equipment, send for Bulletin 968.



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Please send me: ☐ Bulletin 965 Pfaudler Type "W" Drive; ☐ Bulletin 968 Buyer's Guide to Pfaudler Equipment.

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promising from the long lists of routines that are available. Time hasn't permitted trying many of these selected programs for design work, but it appears that about 50 percent of them are well enough prepared to be of direct use.

Some general observations can be drawn from this survey. So far, very few organizations have prepared general-purpose programs for engineering use. Those that have done so do not have many in their library now.

Despite this there is wide recognition of the need for such programs and a strong awareness of the economic benefits that cooperative interchange of engineering routines would produce. In fact, virtually all of the groups that indicated no general-purpose programs now, said they intended to work on them soon.

Proprietary interest, while strong, is diminishing. Probably this stems from two factors. First, companies are finding they don't have enough money to do all they'd like to by themselves; these programs are expensive. Secondly, companies are finding that really worthwhile engineering routines are based upon well-known physical principles and contain virtually no process information; the process data are brought to the computer by the engineer when he uses the program.

Finally, high enthusiasm was shown for the versatility and economic benefits of general-purpose programs by those few organizations having six months or more experience with them.

Good Example. An excellent manual has been prepared by a large utility company. The manual, which took one and one-half years of preparation, contains more than 70 general-purpose routines available on both an unlimited and restricted basis to the 150 engineers in the company's Design group. An outstanding feature of the manual is the write-up on procedures it provides and the fact that a single input format serves all of the programs. The engineer's instinctive desire for standardization has been well served.

An aggressive approach by a large engineering firm has produced a worthwhile collection of general-purpose programs. The attitude of the management has been that the company couldn't afford to be without a computer. The engineering staff responded to this stimulation by setting up a number of general-purpose programs to expedite use of the machine.

Imagination by a small consulting firm in the southwest has resulted in preparation of highly useful programs. The men in charge have recognized the importance of preparing input and output in a form that a production engineer can assimilate. This recognition and the competence of the engineering have produced programs that are definitely salable.

Versatility of another consulting firm in the southwest has permitted it to translate mathematical techniques from one engineering problem to another. This has expedited the preparation of useful general-purpose programs and has permitted customers to launch into new fields of computer application on a very short time-scale.

What Now? This leads us to the question, "What needs to be done" by the industry? The general-purpose program creates the opportunity for a cooperative venture that can benefit all. The mechanics of setting up the interchange of programs are going to require careful attention, though.

The problems to be overcome are somewhat formidable, but the benefits will be large and continuing. The chief problems are:

1. Proprietary interest.
2. Process disclosure.
3. Anti-trust aspects.
4. Inadequate screening and coordination.
5. Incomplete description.
6. Funds to do the work.

The answer seems to be the creation of an agency by technical societies serving industry to collect, screen, and distribute general-purpose programs. The programs should be distributed in the form of well-documented flow charts as a matter of necessity. Machine coding, card decks, or tapes may be optional extras. The membership fee would be one acceptable program not already in the library, and upon payment the member company would receive the library and all future additions.

Three Reeler. This article has given you essentially a motion picture in three reels. The theme was the impact of high-speed electronic computers and thus mathematics on chemical engineering and its problems. The first episode covered the individual chemical engineer, what he is and how he works today, what he could and should do tomorrow. The second reel featured the computer and some checkreins restricting its use. The final scene outlined how a general-purpose computer program comes into being and is an effective money-saver.

However, the last frame is a plea for earnest cooperation in a coordinated, practical way to help one another do a better job of engineering.

Originally presented before the NYU-IBM Symposium on Digital Computing in the Chemical and Petrochemical Industries. # #

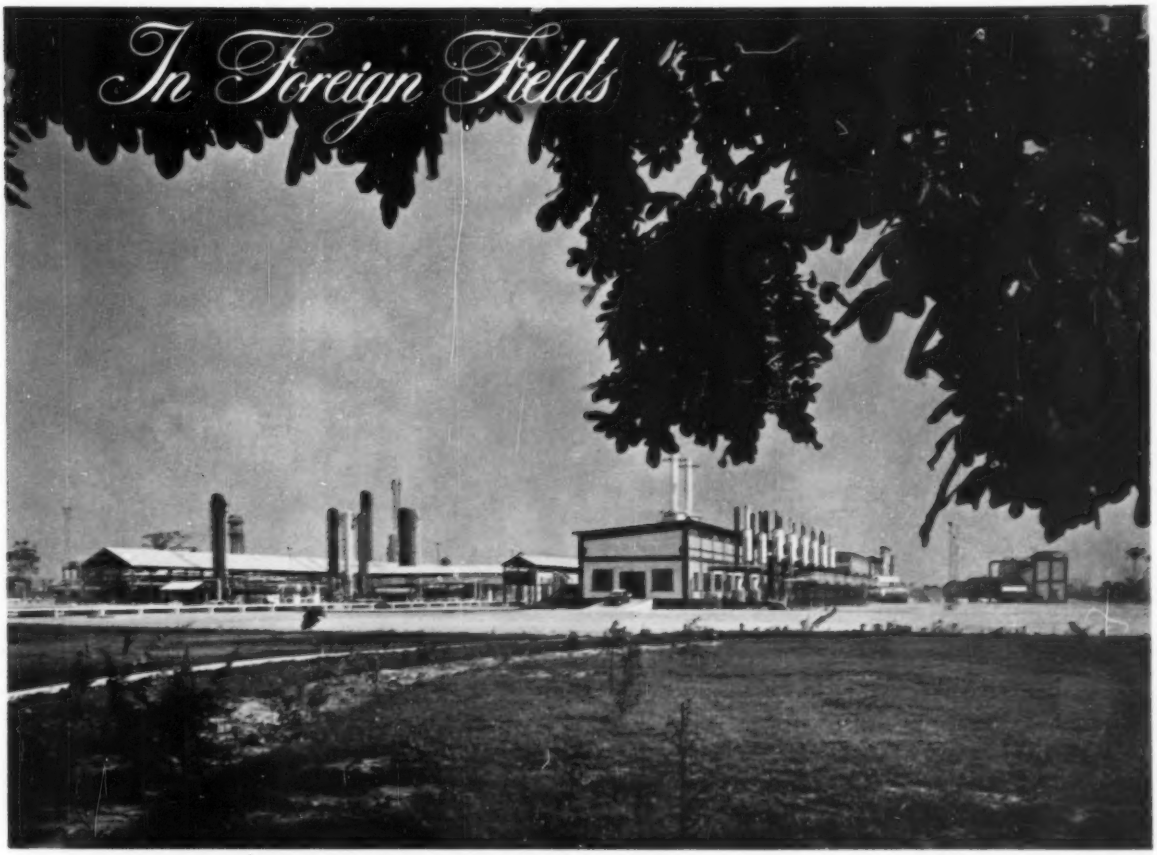
About the Authors

Bartkus

Carlson

Dr. E. P. Bartkus is general director of systems engineering in the Engineering Service division, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. His duties include computer applications and operations research. Bartkus has four years' Army demolitions experience, including ammunition procurement, development, distribution and correct use, with the Mediterranean Allied Air Forces in WW II. He taught chemical engineering at the University of West Virginia, has been a consultant in basic design data development with Du Pont, and has worked in the company's Industrial department in Engineering department liaison, and as manager of the Engineering Computation section. He has B.S., M.S., and Ph.D. degrees in chemical engineering from the University of West Virginia, and has studied summers at Colorado School of Mines.

W. M. Carlson is a senior engineer in the Computer Applications department, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., where he assists design personnel in making effective use of math, statistics and computers. He received B.S. and M.S. degrees in chemical engineering from the University of Colorado, and joined Du Pont in 1939. Carlson's experience includes 13 years in process development and improvement work, including supervision and management. He also has two years in planning studies and four years on his present job. He is chairman of AIChE's Adhoc committee on computer program interchange.



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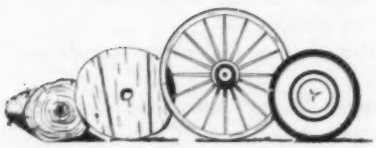

How to Invent: Part 5

Your First Invention—A System

Ultimately, you will work out your own process and method for inventing, but here are some points which form the basis for any system

Forrest E. Gilmore
Independence, Kansas

ADHERENCE TO an established system is generally considered a mental block to creative thinking. Because of this I hesitate to use the word "system" in the heading of this article. Actually, a system for inventing does not enter into the inventive thought process. However, it does contribute a great deal to preparation for invention.

All prolific inventors I have known have acknowledged to me they use a system. Edison's system was one of massive experiment; of repeatedly trying possible ideas to find the right answer. Through this system or method, he also gave the element of chance every possible opportunity.

Edison's system probably told him which problem he should attack; which experiments he should attempt, and the order in which they should be run. It could well be, in some instances, that he started with one experiment and the results suggested the following one, etc., and that this was one part of his system.

"Think Killers." In trying to stimulate the inventiveness of engineers in the capacity of Patent Administrator of a department of a large company I quite often ran into different mental blocks to invention. We can very easily call them "think killers."

It makes no difference whether or not these think killers are based on actual facts or truths. As long as the potential inventor feels that they are real, they can actually retard his creative thought process. To show you what I mean, here are some that I have collected over the years. How many times have you heard your colleagues ask these questions or make these statements? How about yourself?

1. "There are no problems in my work, so what am I to work on to make an invention?"

2. "If inventive ideas are so important, why doesn't the company in scheduling our work, set aside some time for thinking up inventions?"

3. "I tried submitting a few patent ideas but they were turned down, so I guess I don't have any inventive ability.

4. "How do you go about getting a patent idea?"

5. "What should I try to invent?"

6. "I am a chemist in the control laboratory; I run tests according to a standard procedure, so I have no necessity to drive me to inventing and no time in which to do it."

7. "If I know no other fields than the one I work in, how can I think in them and improve something in them?"

8. "Every time I think of something I might invent, I find that someone has beaten me to it."

9. "I am ashamed of the patent ideas I have submitted and doubt that I will submit any more."

10. "I don't want to get a reputation as a screw-ball inventor."

11. "I helped another fellow develop his idea and he took all the credit and the payment."

12. "My job keeps me so busy I have no time for patent ideas."

13. "My boss has no use for people with ideas, he just wants us to do our work with the tools and methods supplied."

14. "I tried to improve a piece of machinery but the engineers up above laughed at me in front of everybody."

15. "One of the fellows I knew invented an important item which the company used and licensed to others but he got practically nothing from it."

16. "We don't have any chance to "brainstorm" anything around here, so how can they expect us to invent?"

17. "I have ideas but don't know if they will work and I have no laboratory in which to find out."

18. "If I invent on my own time, shouldn't the invention belong to me?"

19. "If I were working in the Process Engineering section, I would be working with all kinds of problems and studying what others are doing so I would have a good chance to invent, but in following the operation of a single old unit there doesn't seem to be anything left around it to improve."

20. "Some inventions are worth much more than others; why does the company pay the same for each one accepted?"

21. "I do not feel that I am paid for inventing."

22. "I am always suspicious that any engineer under me who turns in patent ideas is neglecting his regular duties."

23. "Why didn't they teach us in college to invent if it is so important?"

24. "I haven't the time to learn any other field than the one I am working in."

25. "I think science fiction and speculation is a waste of time."

26. "I have always understood that inventors were born, not made; and I do not think I was born to be one."

27. "Why don't they pay us for patent ideas as soon as they are accepted instead of waiting until the patent is issued and why does it take from two to four years after we submit an idea before we get our final pay for it?"

28. "The Company pays for suggestions immediately and according to how much it is estimated they earn and publishes in our Company publication the name of the man making the suggestion and the amount paid him. Why don't they do the same with patent ideas?

29. "Why don't they use more of our ideas they patent; what good are they if they are not used?"

30. "Why doesn't the company send us a list of problems that need solving so we can pick some to work on?"

31. "I'm well satisfied with my job and things as they are; I think things will work out OK as long as I do my assigned work without bothering about trying to set the world on fire with creative ideas. All I want is security and time to be with my family and to go fishing."

32. "I hope to advance through the supervisory route; what would be my chances were I known as a screwball inventor?"

A system for invention which fits one man will probably be no good for another. Ultimately, however, every would-be inventor should work out his own system and use it.

Ideas come to those who are looking for them. Therefore, you should use a permanent notebook to record all of your observations.

33. "Some of these fellows are always trying to figure out some way of getting out of work, making some contraption to do the work for them; I think they are just plain lazy and they shouldn't be paid for it."

This long list of questions and statements cover most of the mental blocks I have encountered. If you feel there are good reasons why you cannot or should not invent, be sure they are adequate, and not merely "think killers." A good idea in this regard is to list all such reasons, then apply logical thought to determine if they are real and advantageous to you or if they should be promptly kicked out of your mind.

Tailored to Fit. No doubt an intelligent person with a fair understanding of psychology and engineering or science, could learn the fundamentals of invention. Then in time he could devise a system to fit individuals of known interests and personalities. It could be used somewhat like a checklist to assist in invention. A system suitable for a highly experienced process engineer might help a beginning engineer or a mechanical engineer. However, it would not be as good as one designed especially for the individual.

Ultimately, every would-be inventor should work out his own system, put it into writing and use it. You should remember, however, that there are some methods which belong in every system for invention and which we will now discuss separately.

Use a Permanent Notebook to Record Observations. There is always a point of beginning, so this notebook idea is recommended as the first step to invention by intention. Ideas come to those looking for them, so if you are prepared to write them down and use them, they are more apt to come. What it amounts to, is that you'll train yourself to observe closely so you'll have something to write in your notebook. These observations should be about such things as:

1. All real problems which arise in connection with your job which might be improved by inventive thinking. Imperfections in equipment or processes such as you may be operating and any ideas you may have to correct them.

2. New processes, equipment and materials from technical magazines or popular news, which you might apply to your own field of endeavor or which might make possible improvement in something you deal with. Also, any possible uses you can think of.

3. Notations concerning problems of other fields of endeavor as disclosed by reading or discussion with those engaged in such fields, or by personal observation when visiting such facilities. Compare these problems with similar problems in your own field and see if some common solution might lead to a new idea. Some new material may make possible a new type of process or new equipment that would not have been possible previously.

4. The economics of new processes and inventions of all kinds which you are able to obtain. Then, see if there isn't some by-product that can be recovered at a profit by means of some new process or equipment you can conceive.

5. Apparently important patents recently issued affecting your field of operations or other fields in which you are interested. Write out analyses of such patents and try to make improvements in them or how otherwise the function of the patent could be performed.

6. Speculations about the future of various fields of endeavor and inventions likely or possibly to be made.

Most research organizations require the keeping of very detailed notes of all observations in consecutively numbered notebooks with the signatures of the observers together with the dates on each page. Part of this is for patent purposes which will be discussed in a later chapter, but it also makes available a review of the experiments without depending on memory. Writing information also plants it more deeply in the mind so intuitive ideas are more likely to spring forth.

The same is true with the non-professional researcher operating in the laboratory and environment of his mind. This notebook habit is the most important part of any

One good method is to look for some function which can be performed through certain combinations of ideas. Then invent a use for that function.

good system to improve invention. If you are out on the job most of the time, it may not be convenient to carry a large notebook but you can note your ideas and observations in a small pocket notebook or even on a blank piece of paper and then transfer them to the permanent notebook at your convenience.

All the notes you first take need be only enough to help you recall what you are to put into your permanent book. Also, it is well to make a carbon copy of each notation. These carbon copies may be useful to include with any ideas you conceive and submit to your company for patent consideration, or even to your patent attorney should you be working independently. It is good practice to divide your notebook into sections dealing with various subjects and after every observation or idea leave room for future notations of observations newly taken or new ideas of previous observations and ideas.

Set Your Norm of Inventions and Stick to It. Everything we do well in this world is mostly the result of habit. Therefore, to invent well you must obtain the habit of doing it. You can set a numerical standard of performance and then change it from time to time as judgment indicates.

As you follow directions and practice, you will find that the opportunity to invent and improve things is so great that you can make considerable more than you would first anticipate. As a beginner, you should set your norm of invention at about one per month with the intention of doubling it in about one year.

Keep a Patent Idea Record. This may well be the notebook you use to record observations, or a particular section of it, or it may be a file where you keep sheets of paper containing sketches and observations of new ideas, possible applications, clippings, and other items which suggest inventive ideas. Any inventive ideas you have should be noted on some convenient piece of paper immediately and in sufficient detail so that they can be worked out more completely and put in the record when the time is available.

Take Time and Invent. If your job permits, set aside some definite time for inventive effort; two uninterrupted hours on two days each week would seem reasonable for the average engineer. If you cannot do this on the job try to set up some regular time at home when you can concentrate to the greatest extent. I find that my best time is between four and six o'clock in the morning while lying in bed.

At first do not go in for quality but try for quantity. Try to invent all sorts of things. Give the imagination the greatest possible freedom no matter how ridiculous the outcome. Judge yourself solely by quantity and give yourself extra credit for the unusualness of your ideas, but keep criticism down.

Put every such idea in your patent idea record. When you have at least twenty-five patent ideas, start studying them for some practical application which can perhaps be obtained by some changes or by combining two or more of them in some novel way. Record the new ideas generated by association with the others. As this record of patent ideas grows, it becomes a means by which you can "brainstorm" with yourself.

The technique of "brainstorming" for ideas is based on the mental phenomenon of association. Psychologists claim intelligent men, such as engineers and scientists, get ideas from association of similarities. The usual ideation type of "brainstorming" is not particularly suited to the engineering type of invention although it is not to be ruled out as a valued technique.

You might get the same association of ideas when inventive ideas are desired, by reviewing the patent ideas in one's patent record. You should also look for some function which could be performed by certain combinations of the idea. Then try to invent some use for the function so disclosed.

Look into the Future, You May Find Invention There. Dr. Charles F. Kettering is reported to have stated: "We should all be interested in the future for that is where we are going to spend the rest of our lives."

Most inventors are busy inventing for apparent immediate needs, so there is tremendous competition in supplying such inventions. There usually comes a psychological time for such inventions; whenever the need becomes gen-

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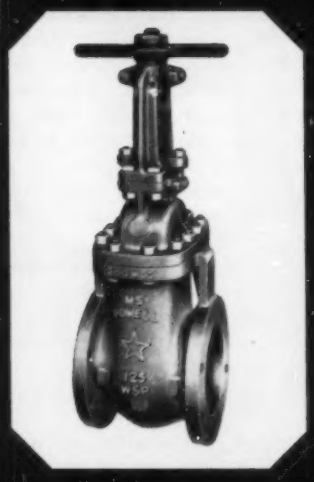

Fig. 1793 — Large Iron Body Bronze Mounted Gate Valve for 125 W. S. P. Outside screw rising stem and yoke, solid wedge disc. 8" and larger valves can be supplied with split wedge disc. Also available in all iron.

Fig. 559 — Large High Test Iron Body Bronze Mounted Swing Check Valve for 125 W. S. P. Heavily bolted iron cap. Renewable bronze seat rings, discs or disc facing, disc hinges. Can be used in horizontal or vertical position. All iron valves also available.

Fig. 1503 — Steel Gate Valve for 150 pounds. Outside screw rising stem. Heavily bolted bonnet and yoke. Precision fitted, accurately guided solid wedge disc. Valves with welding ends can also be supplied.

Fig. 1460 — "Master Pilot" Gate Valve for 150 W. S. P. Iron body bronze mounted. Bolted flanged bonnet with inside screw rising stem, solid wedge disc. Can also be furnished with flanged ends, and in all iron.

Fig. 8150 — Bronze L. P. Gas Globe Valve for 400 W. O. G. Union bonnet, inside screw rising stem, special composition disc, integral seat. Listed by Underwriters' Laboratories, Inc. Angle, Gate, Lift Check and Steel Valves available.

Fig. 1559 — Steel Lubricated Plug Valve for 200 pounds W. O. G.—A. S. A. 150 pounds. Screwed gland type. Single gland and bolted gland types can also be furnished. Large Valves—6" and above, can be supplied with gears for gear operation.

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erally apparent and processing techniques, new methods of manufacture or operation or other knowledge permits the invention to emerge.

Several inventors may make the same invention at almost if not the same time. This is quite discouraging to all but the successful one, but frequently he has a great deal of trouble getting patent protection.

You will find a much less crowded track on which to run your inventive race if you get off the crowded highways of the present and use the imaginary ones of the future. However, for apparent practical reasons, the best policy is to not look too far into the future but to try to anticipate the more immediate needs. All you have to do is to observe the trends and project them into the future.

For instance, suppose you are a process engineer in the oil refining industry. You would know that most of the new processes in the industry for the past decade, at least, have been designed to meet the requirements of the octane race and you would have available anticipated octane requirements for each year for several years ahead. You would also know that many of the present processes could not produce gasoline of the quality required and others could not produce it economically. This means that within a few years, if the anticipated octane requirements are met, most of this equipment presently used must be abandoned or somehow converted to be used in new processes.

You can readily determine the chemical composition of the hydrocarbons needed to meet the future needs. If you could produce some exceedingly high octane material, such as triptane, you might be able to use some of the present processes which you could not otherwise do. The problem of future utilization of present refining units has not been solved by recently offered new processes.

There is a world of invention potentialities tied up with this continuing problem. You do not need to be acquainted with electronics or atomic energy problems to tackle this one. Perhaps you could be the one to solve some important part of it, or to incorporate information supplied to you through the usual reports of the Research and Development organization of your company, into some process. Frequently, the scientists conducting the research are not as good at incorporating the information they discover into processes as the process engineer following the operation under study. Also, other engineers may improve the arrangement of the process equipment developed by research in such a way as to constitute invention.

Reverse the Normal Workings of Thought. All knowledge normally points in a certain direction or is taken from a certain point of view. You can see it differently by changing its direction or its viewpoint. How different from ours must be the worlds of the ant, bird, worm and fish.

One of the most prolific inventors I have known advised me that most of the inventions he has made were through reversing the normal workings of thought. He was always looking for statements that something couldn't be done because of some given conventional reason; statements similar to those of a prominent scientist that Edison was wasting his time on trying to make his incandescent light for it was well known that you could not produce light without combustion.

This inventor friend of mine assumes such statements are wrong and tries the idea out in his laboratory which in this instance happens to be the kitchen of his home.

You should never have too much reverence for theories widely accepted as facts; there may be certain exceptions that give a clue to some new inventive idea. When I was in college, a great deal of stress was put into the statement that you could not destroy matter i.e., the atom was indestructible and unchangeable. If all scientists had firmly believed this, we would have no such thing as nuclear energy and all the inventions associated with its production and use.

Analyze Your Problems and Practice Stating Them in Writing. The recognition of a problem may be your most important step to invention. Determine what you wish to accomplish rather than the methods or devices used at present by your analysis. Then, put it in writing. A complete, clear statement of the problem is a good start toward solving it.

Divide the problem, if possible, in order to simplify the analysis and to make it easier to visualize. The precise statement of the problem should be in a general way, in functions rather than in apparatus or known methods. Then write down all the answers in a general way, making an effort to approach the problem in every possible direction, i.e. try to get solutions in all applicable fields such as by electricity, hydraulics, mechanics, physics or chemistry.

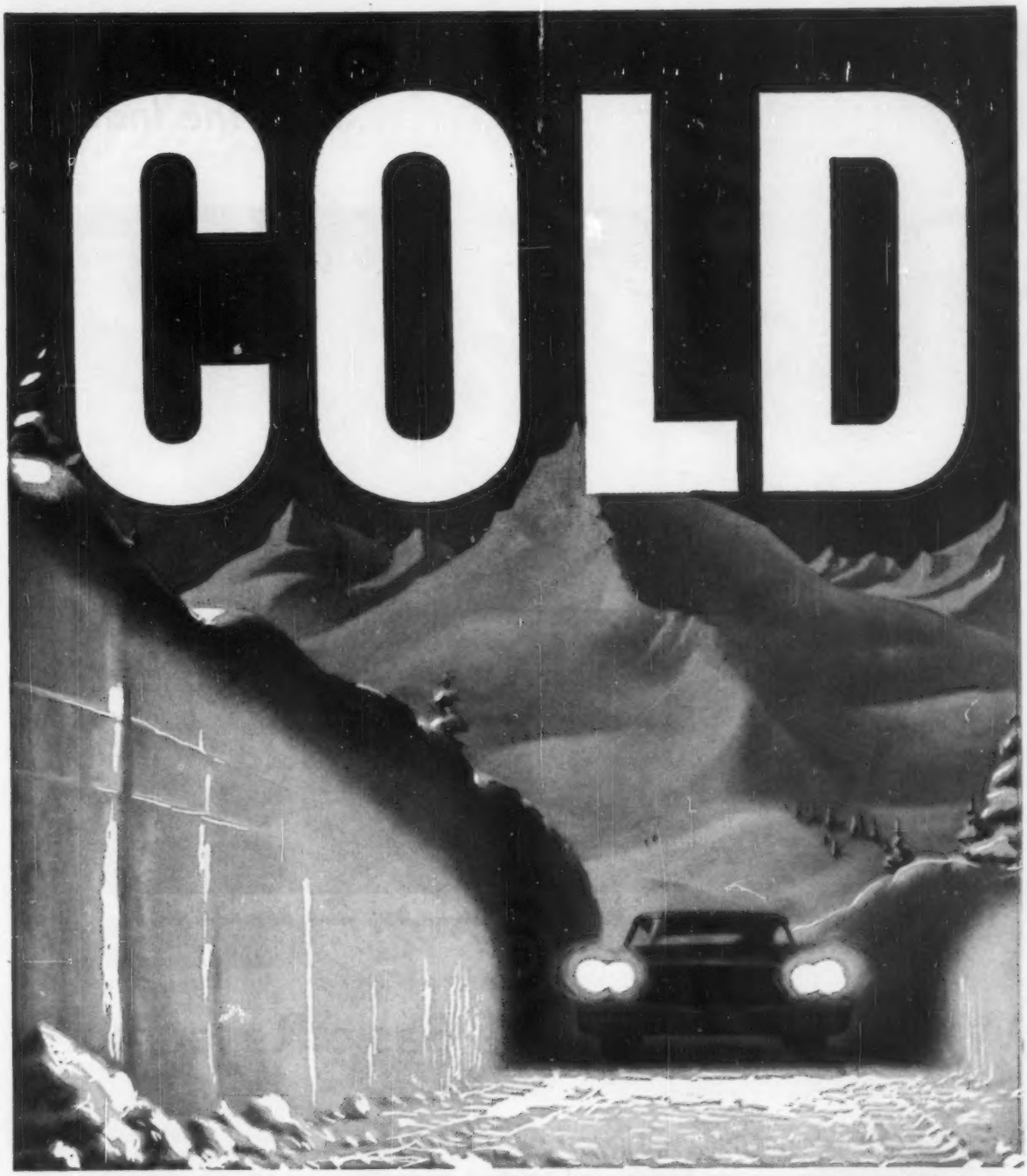
Develop in Yourself a Philosophy of Invention. All human activity is based on some philosophy. Many things enter into the master inventor's philosophy but the basic beliefs are that nothing is perfect and nothing is impossible. They wish to know about everything and how it works. They are not satisfied with things as they are and are continually speculating on things yet to be.

You must study and observe in order to store up information about the relationship of things and ideas and gain experience in many fields in an effort to seek and find. Bernard Benson noted, "Divine Inspiration does not fall on anyone, with or apart from a group, who lacks valid knowledge and experience and doesn't apply systematic thought to a problem."

Obtain a Sufficient Knowledge of Patent Law and Procedure. The next article will give the basic information needed. No attempt will be made to go into the subject in detail for the engineer-inventor needs to know only the part that practically concerns him in connection with his inventive effort. There is no use inventing something that is not patentable and it is well to understand how to protect any invention one may make. Some knowledge of patent law and its interpretation by the courts and the procedure necessary to obtain a patent as well as the meaning of a patent will help you in your effort to become a successful inventor.

In "How to Invent: Part 6" which will appear next month, Mr. Gilmore will explain such highly interesting and informative topics as:

1. **What is a patentable invention?**
2. **How can I obtain a patent?**
3. **Just what does a patent mean?**
4. **Can I practice my invention in secret?**
5. **What else should I do to protect my invention?**



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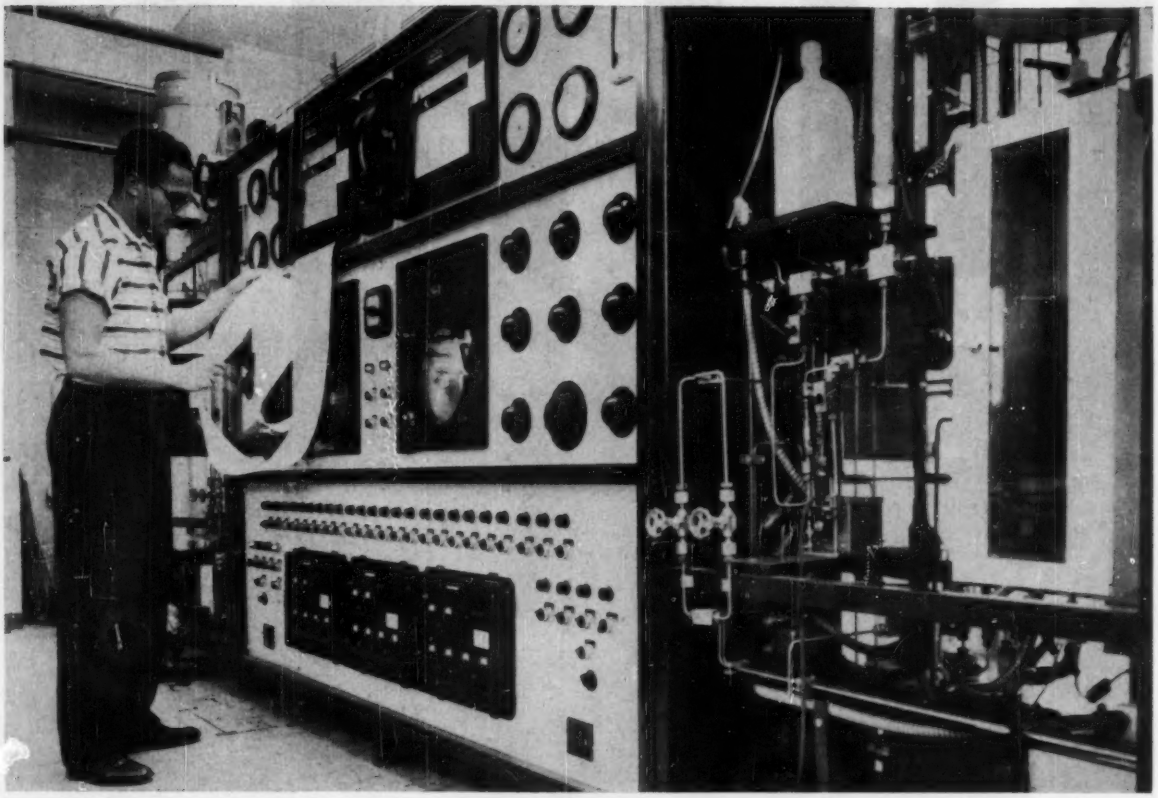
What's Happening . . .

. . . in the Industry



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Much, though not all of the Washington Center's work is along petroleum lines.

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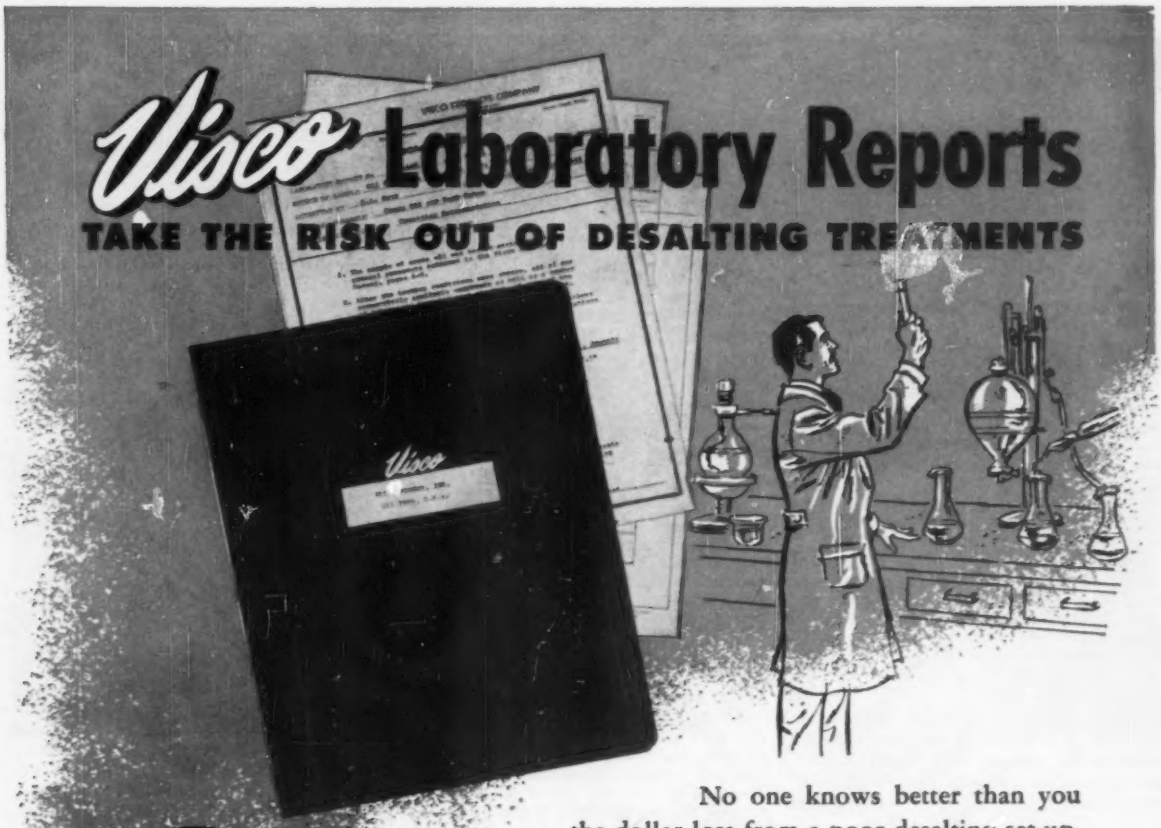

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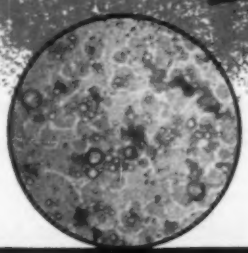

Photomicrograph— Emulsified refinery crude

In a typical case, 20 or more separate desalting compounds and laboratory formulas may be checked and all contributing factors will be considered before the final desalting recommendation is made.

Photomicrograph—Emulsified refinery crude after Visco desalting

If you would like our desalting recommendation for your crude, send Visco a five-gallon can of the crude and one gallon of the water used in your refinery desalting. Or better yet, check with your Visco representative, and he will arrange for these services.

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What's Happening. . .

cient and more selective catalysts (including clay catalysts) are being sought.

Engine knock—A standard cylinder is used to compare known fuel samples with those of experimental fuels.

Polymer behavior—Polymers are being experimentally modified through bombardment with two-million volt electrons from a Van de Graaff accelerator, to develop unusual properties such as high temperature stability and resistance to oxidation.

New Product Development—Light stabilization of polyethylene is being studied.

The Polymer Chemistry department is concerned with converting monomers to plastic polymers. Using ethylene and propylene as raw materials, polyethylene, polypropylene and other polymers in the polyolefin family are being formed experimentally. Many of the experiments are carried out in batch reactors for exploratory polymerization studies.

In other work carried on at the Center, crude oil hydrodesulfurization is being conducted on a laboratory scale. Natural gas derivatives utilization is being conducted. Mass spectroscopy is being used for analysis of petroleum fluids and for contamination detection. Nuclear fuels are also a subject of research work.

Expansion of the Center's facilities is expected to continue in the future as dictated by the needs of W. R. Grace's activities in the chemicals field, both in the U.S. and abroad.

Economist Predicts Oil's Future Expenses

An oil company economist has predicted that the free world must spend $1 billion a year during the next 20 years for new refining capacity to keep up with a "truly dynamic" expanding demand for petroleum products.

The forecast was made by Austin Cadle, manager of the Economics department, Standard Oil Co. of Calif., San Francisco. He addressed a petroleum statistics session at the 38th annual meeting of the American Petroleum Institute.

By 1975, total free world energy requirements will nearly double to 75 million bpd in oil equivalent, Cadle said. Of this demand, 50 percent will be met by oil, he added.

The U.S., Cadle said, will need the equivalent of 35 million more bpd of oil by 1975—an 83 percent increase. He predicted petroleum's share of the total demand would drop two percent, but that this still would mean a 76 percent increase over current production. The principal restraining factor on U.S. oil demand is the competition of natural gas, he said.

In a sweeping forecast, Cadle predicted that by 1975:

- Total U.S. gasoline demand will double under the impact of growing population, multi-car families, shorter working hours, and longer vacations.
- Use of light fuel oils (distillates) in the U.S. will increase 47 percent because of mounting mobile and stationary power uses and complete dieselization of the railroads. This will be offset somewhat by natural gas competition for the heating oil market and expanding use of residual fuel oils in diesel engines;
- Heavy fuel oil use in the U.S. will suffer great competition from alternative sources of energy and will increase in demand only 14 percent;
- In the free world outside the U.S., gasoline demands will increase 300 percent;
- Light fuel oil demand in the western hemisphere will increase 20 percent, in Western Europe will treble, and in the eastern hemisphere will rise 300 percent;
- Heavy fuel oil demand in the western hemisphere will rise two-and-a-half times, will jump 259 percent in Western Europe, and 202 percent in the eastern hemisphere.

In addition to predicting a $20 billion expansion in refining capacity—76 percent in the U.S.—Cadle saw a need for the equivalent of 6,500 T-2 tankers, compared to 2,300 in 1957. And, he added, the need for more terminals, marketing outlets, crude oil and product transportation facilities "come to an investment figure staggering to the imagination."

Cadle, viewing the future competition of nuclear energy, said that the combined capacity of all electric generating plants in the U.S. and Europe scheduled by the mid-60's "is considerably less than the capacity added to the U.S. total power system in the course of a single year."

"On the basis of current cost predictions," he said, "it is difficult to visualize any extensive developments of nuclear power plants for another 10 or 15 years. Even if all such installations in the long-term future were to be nuclear, it would replace a very small percentage of the total consumption of liquid fuels."

Fuel Cells May Power Autos Soon Says Lockheed

A "fuel cell" with almost 100 percent "fuel" utilization, and energy conversion efficiencies of 70 percent or better, is in the advanced development stages at Lockheed Aircraft Corp.'s Missile Systems laboratory, Sunnyvale, Calif.

Dr. Morris Eisenberg, heading work on the new cells, predicts it will be sufficiently developed within five years to "yield enough energy for powering an auto or plane."

The cell is unlike a battery—electrochemical fuel is stored outside the cell, so its components are not consumed in electrode reactions as they are in a battery.

Lockheed is working on a cell to produce 100 watt-hours per pound, and says a 300 watt-hour cell will be developed within five years. Automobile batteries produce 8-10 watt-hours per pound.

Eisenberg said fuel can be any high-energy material, gas, liquid or solid, such as hydrogen, oxygen or chlorine.

Government Domination of Oil Risked Says Johnson

Senator Lyndon Johnson (D-Tex.) recently warned the oil industry that it is courting domination by the federal government in seeking solutions to its internal "political deadlock." Johnson told the Independent Petroleum Association of America that each danger is accented particularly in the current disputes over imports.

He said "each segment, the independents and the importers, is seeking a favored position. The net result is the same acceptance of federal domination for a federal favor. All industry is facing or is about to face this same challenge."

The Senator advised the oil industry to drop the "get it alone approach," and devise a free-enterprise way out.

Petroleum Industry Data Is Denied to U.S.S.R.

The Commerce Department's Bureau of Foreign Commerce has given permission for U.S. firms to turn non-military technical information over to the U.S.S.R., but has rejected technical data license applications dealing with oil operations.

Among the application rejected have been petroleum refining plants, data relating to exploration and production, and certain petrochemicals and plastics which have highly strategic applications.

F. W. Sheaffer, acting director of export for the Bureau said, "a number of applications and inquiries are under study. I regret that I cannot tell you specifically what they cover, as this might uncover someone's business deal to a competitor." He added that application processing is a touchy problem because "often non-military items can be converted to military purposes. For example, "the same type plant producing motor grade fuel can make aviation fuel, and the same type plastic used in squeeze bottles is adaptable to proximity fuses and communications wire.

Refining Capacity Hike Of 9% Seen by September

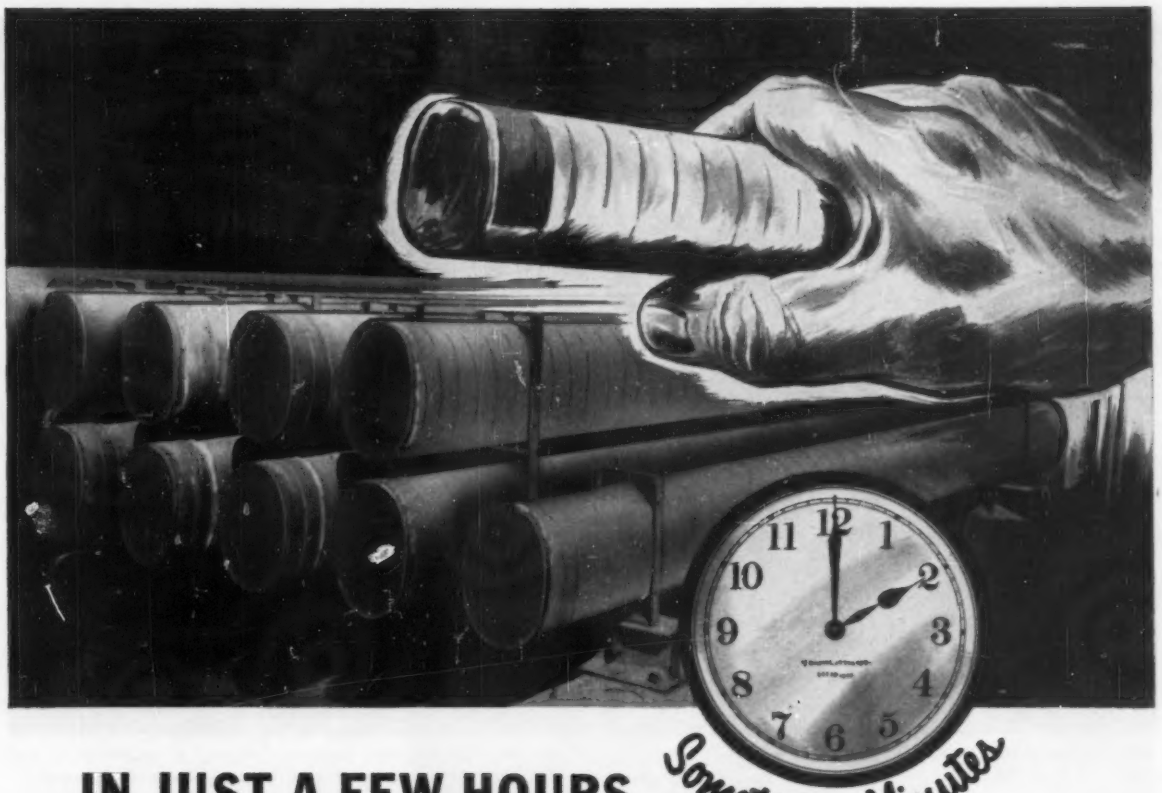
An API survey shows that in the first nine months of 1959, operatable refining capacity will be increased by 0.9 percent, from 9,683,100 to 9,771,950 bpd. The year-end figure is one percent higher than the 9,593,600 bpd reported for September 30, 1958.

The totals exclude 60,600 bpd capacity from plants which were, on September 30, shut down for repairs. Included was 468,950 bpd capacity which, while operable, is regarded as in the high-cost marginal group and was also shut down.

Action in Politics a Must According to Conoco Veep

The American businessman will soon be out of business and the ward of a socialistic government if he doesn't change his apathetic attitude toward politics and government affairs, according to Charles A. Perlitz, Jr., executive vice president, Continental Oil Co.

Speaking to the Texas Personnel and Management association, he said the average businessman's attitude of detachment and indifference is creating a fertile field for those "who would shackle or destroy our free enterprise system to serve their own selfish, political ends." He urged businessmen to study objectively all sides of



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Brown Heat Exchangers can be changed to meet any duty!

One key to profitable petroleum operation today is flexible equipment that can be rapidly adjusted to meet any desired capacity dictated by market conditions. Brown Fintube sectional units, unlike single-unit shell and tube exchangers, are easily and quickly added or subtracted to meet any desired capacity.

When cutbacks are necessary, you remove or valve off the required Brown sections. If capacity expands, you simply add or valve on enough sections to meet requirements. At a moment's notice with minimum maintenance, you are operating efficiently on any new or different capacity situation.

Because of this extreme usage flexibility, Brown high efficiency units are never obsolete, never in a scrap yard, or on the used equipment market. They are where they belong, *profitably* working for you.

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Please send Bulletin 512 containing description, advantages, uses, specifications, details and selection data on modular Brown Units.

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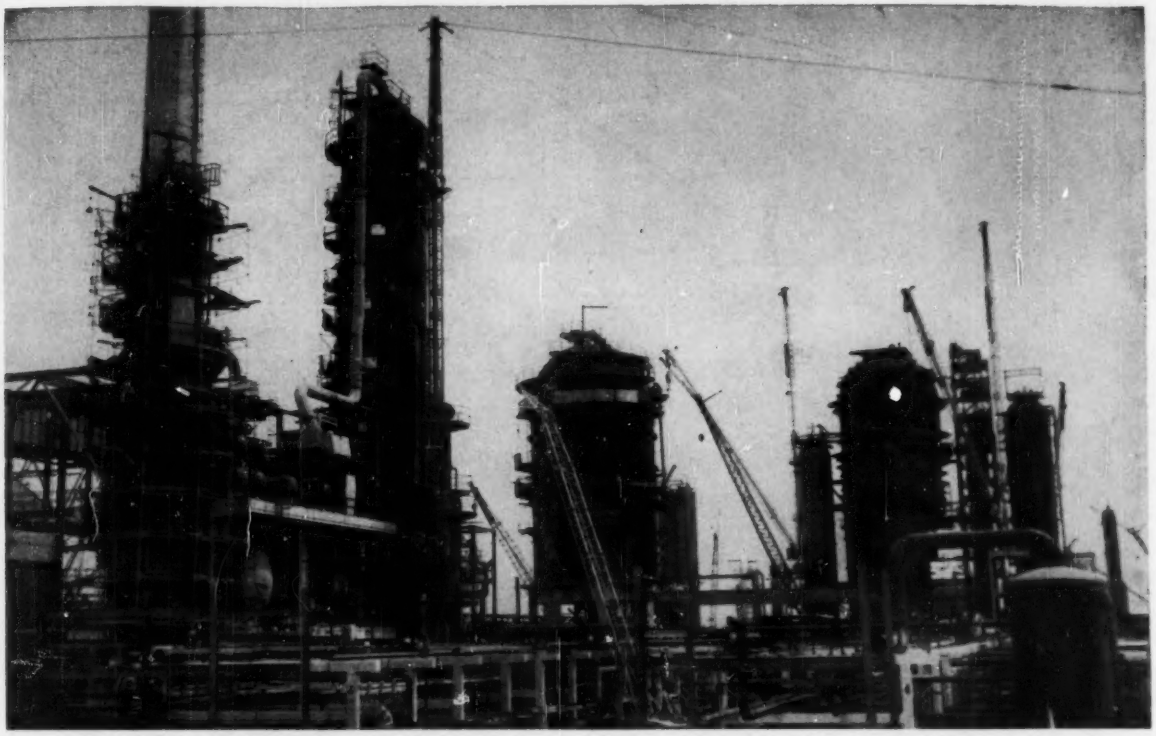


A dozen vessels built by Newport News were furnished under contract with C. F. Braun, Inc., of Alhambra, Calif., design engineers for the ultra-modern Delaware Flying A Refinery of the Tidewater Oil Company located 15 miles south of Wilmington.

Newport News builds 12 major components for new Flying A 130,000-bpd refinery

This is the Tidewater Delaware Flying A Refinery while under construction near Wilmington.

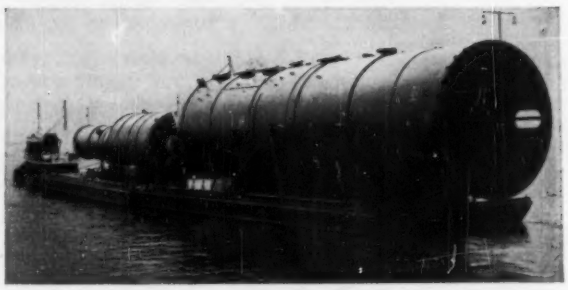
Newport News fabricated 12 of its major vessels — 2 of which are the largest such units ever built: a 250′ Orthoflow fluid "cat cracker" converter and a 225′ reactor scrubber of the fluid coker.

More notable than size, though, is the quality of the Newport News fabrication.

Coke-out screens in the reactor scrubber, for example, are made of 704 12% chromium segments. Welded together with accuracy, they provide 45% clear opening . . . with opening tolerances less than 1%.

You get expert fabrication, the skill of specialists when Newport News builds your equipment. When you want reactors, pressure vessels, vacuum tanks and the like, sub assemblies or weldments in almost any size or shape, get a bid from Newport News.

Send for newly published, easy-to-read, illustrated booklet, "Facilities and Products". It describes the many ways in which Newport News can help you with present or future projects. Write for your copy today.



Full advantage was taken of the Newport News deep water loading facilities for transportation of all of the equipment by barge. Shop erection prior to shipment assured fast, trouble-free field assembly.

Engineers: Desirable positions available at Newport News for Designers and Engineers in many categories. Address inquiries to Employment Manager.

Newport News Shipbuilding and Dry Dock Company, Newport News, Virginia

What's Happening . . .

proposed legislation and courageously take a stand one way or the other.

Some of Perlitz' other remarks were:

- Recognize that to run from controversy is to abdicate your opinion.
- Avoid blanket, unreasoning opposition to any and all legislation.
- Don't run to Washington or state capitals for help on all competitive problems or to ask special favors, without first reflecting upon the costs of such favors to our economy as a whole.
- Encourage employes to participate in politics.
- Keep informed on occurrances in Washington and the world at large.

U. S. Demand to Jump 4.3 Percent in 1959 Says IPAA

The Supply and Demand committee of the Independent Petroleum Association of America has predicted that domestic export demand next year will be up 4.3 percent over 1958 to 9.66 million bpd. Domestic requirements alone are expected to rise 4.5 percent to 9.4 million bpd, with exports dropping 4.5 percent to 257,000 bpd. The 1958 domestic demand is expected to run 8.99 million bpd, up 2 percent from 1957.

This year's total demand will be down 1.3 percent according to the committee, because of a 52.1 percent decline in exports. Next year requirements will reach 9.68 million bpd, or 546,000 bpd more than in 1958, the committee said.

Other estimates made by the committee included:

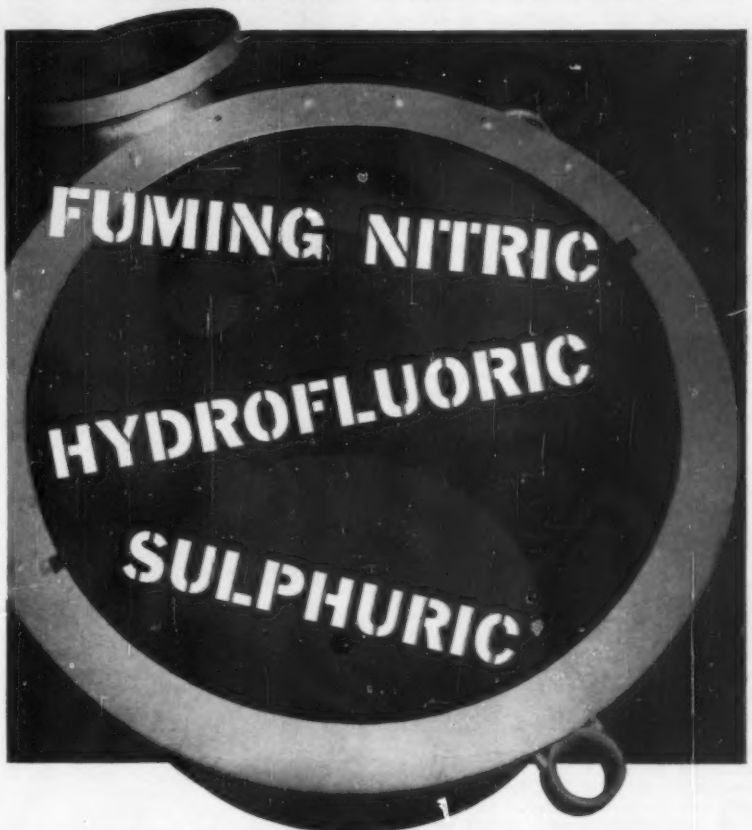
- 1959 new supply need in first quarter, 9.7 million bpd; in second quarter, 9.52 million bpd; in third quarter, 9.6 million bpd; and in fourth quarter, 9.86 million bpd.
- 1959 new supply made up of 8.81 million bpd of domestic crude production

Chemicals Wanted

The National Registry of Rare Chemicals, Armour Research Foundation, 33rd, Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the registry.

1,5-Anthraquinone
Dipropyl disulfide
Lauryl methyl ketone
n-Pentacosane
n-Dotriacontane
n-Hexacosane
n-Octacosane
Pentaphenylethane
n-Tetratriacontane
l-Phenylcyclohexene
bis-Aminoethyl methylamine
α-Methyl styrene oxide
1,7,7-Trimethylbicycle [2.2.1] heptene-2 (Bornylene)
2,2,3,3-Tetramethylbutane
2,2,3,3-Tetraphenylbutane
Trimethylacetonitrile (tert-Butyl nitrile)
Tricyclodecane (Adamantane, Diamantane)
Prehnitene (1,2,3,4-Tetramethylbenzene)
1,2-Dibromocyclobutane
N-Methyl pyrrole

UP AGAINST THE WORST?



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Certified Applicators:

Atlas Metal Protection, Inc. Houston, Texas
The Barber-Webb Company, Inc. Los Angeles, Cal.
Belke Mfg. Co., Inc., Chicago, Ill.
Buckley Iron Works, Dorchester, Mass.
Electro-Chemical Engrg. & Mfg. Co. Emmaus, Pa.
Metalweld, Inc., Philadelphia, Pa.

Chemiseal Linings are impervious to *all* the most difficult acids, alkalies and other highly corrosive chemicals. They permit you to handle such chemicals with ordinary plant equipment.

In addition, they withstand temperatures from −320° F. to +250° F. Have high impact strength. Are tough—not brittle. Are readily cemented over any contour and to any material of equipment construction. Seams are heat-sealed into a continuous, chemically-inert surface.

Chemiseal Fluorocarbon Plastic Linings are available through certified applicators (listed at left), who are trained and equipped to insure best results.

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Special Products Department
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United States Gasket

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and imports, and 825,000 bpd of natural gas liquids.

• Percentage of rise in demand over 1958 levels—gasoline, 3 percent; kerosine, 3.2 percent; distillate fuel oil, 5.3 percent; residual, 2.9 percent; and other products, 9.1 percent.

SAMA Predicts Big Upsurge In Engineering Employment

Jobs for qualified scientists, engineers and technicians are due for a big increase in the next ten years. Results of a recent survey by the Scientific Apparatus Makers Association public information committee, indicate how top executives of the country's 500 largest firms estimate their increased technical personnel requirements for 1968. They were asked to estimate percentage increase or decrease in technical jobs in their industry.

A substantial 27 percent of those who replied said that ten years from now their industry would have double the present number of technical jobs. Another 13 percent thought that the increase would lie between 50 and 100 percent. In all, 60 percent of the men forecasted increases of 25 percent or more.

The SAMA committee conducted the survey to guide capable young people now beginning high school as they planned their careers. Committee spokesmen point out, qualified scientist-engineers and technicians so badly needed a decade from now must be "recruited" today.

Food, chemical, rubber, petroleum, electrical and instrument industries led the industrial group in their projected professional needs with furniture and paper pulp indicating lesser growth needs.

Of 500 questionnaires mailed by the SAMA-PI committee, 103 were returned. Sixty-seven gave usable (percentage) figures. Among those responses roughly one-third were from chemical or related industries, e.g., petroleum, rubber, etc.

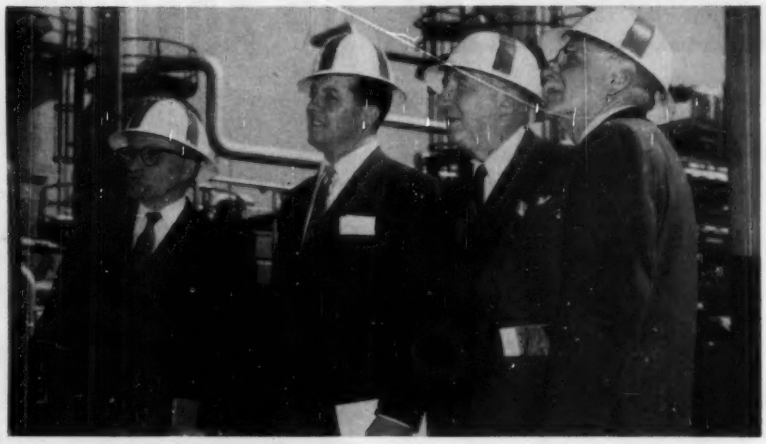
The SAMA committee felt that this year, when the demand for new technical graduates slipped to its lowest point, the study would be most timely in reaffirming America's potential for professional people.

SAMA survey results become even more significant in the light of recent studies at Hughes Aircraft Co. Here it was found that 70 percent of technical employees decided to enter scientific fields well in advance of high school graduation. Career decisions were made in the seventh and eighth grades by 41 percent, while 29 percent decided in high school.

If the demand for scientist-engineers by 1968 will be doubled and more in relationship to today's demands; technicians or scientist-engineer helpers—"hands"—are in for even greater job opportunities. This was learned when the SAMA survey posed another question to the country's leading executives: "What's the 1968 outlook for technicians and engineering helpers?"

A promotional summing up the SAMA committee's studies of projected percentage increases of jobs for scientist-engineers and technicians in 1968 is now being prepared for distribution to the nation's educators and guidance personnel.

Single copies of the study summary will soon be available for distribution without charge. Please write: "1968," Scientific Apparatus Makers Association, 20 North Wacker Drive, Chicago 6, Ill.



Members of the Mont Pelerin Society, an international economic organization, recently toured Tidewater Oil Co.'s Delaware refinery after a previous visit to E. I. duPont de Nemours & Co., Wilmington. The visitors are, left to right: Louis Boudin, of the University of Paris; L. Augustin Navarro, director, Institute of Economics, Mexico; Harold Brayman, director, Public Relations, DuPont; and Professor F. Knight, University of Chicago.

Humble VP Foresees No Demand Problem

Although seasonal swings pose a continuing problem, the refining industry has adequate flexibility in physical facilities to meet any foreseeable variations in product demand, says H. W. Ferguson, vice president of Humble Oil and Refining Co.

Ferguson, speaking on "Refining Flexibility and the Problems of Seasonal Demand," told the American Petroleum Institute's 38th annual meeting that his company had made a statistical analysis of the supply and demand situation for gasoline and distillates, as it existed historically.

"Calculations were made to arrive at the maximum variations in demand which, barring an emergency, could reasonably be expected," he told group session on refining. "The results of this study indicated to us that the refining industry can, in all probability, meet future variations in demand with only a small variation from an optimum use of seasonal storage. Even an emergency such as the Suez Canal closure could be met, this study showed, unless it occurred during a colder than normal winter."

Ferguson, who is retiring as vice president of API's Refining division, discussed three methods which the refiner has at his disposal to meet variable demands for his products: He can vary his crude run and the yields of its products, and he can use seasonal storage.

The latter two methods, he said, offer the most economical ways of meeting variations in demand: the diversion of low octane gasoline fractions to middle distillates, and maximum withdrawals from seasonal storage.

The growing use of natural gas pay eventually cause the seasonal factors to be less of a problem, Ferguson said. More gas furnaces than oil burners are going into new homes, and there has also been a marked tendency for oil consumers to convert to gas. By 1963, some economists predict, the number of oil burners in the nation will start to decline.

"To the extent that the demand for heating oil falls off," Ferguson said, "the refining industry will be approaching a more even status, with weather having less effect on variations in demand."

He emphasized that the individual refiner must look at his own supply-demand situation in deciding how he will use the available methods of flexibility to meet his own demand requirements.

Network Educational TV To Be Offered By Stancal

Standard Oil Co. of Calif. joined five other American corporations recently in an unprecedented national network educational television experiment.

The new program provides college credits in modern physics to an estimated 15,000 high school science teachers, about one-fifth of all such teachers in the country. More than 300 colleges and universities are planning to offer credits to teachers and students who register for the course.

The Ford Foundation and the American Association of Colleges for Teacher Education inaugurated and will coordinate the program with NBC.

The program is the first coordinated effort to provide a planned, accredited college level TV course on a country-wide basis. It is designed to improve science education in high schools

Oil Heat Plan Advanced Through New API Council

American Petroleum Institute's Fuel Oil committee has created the National Fuel Oil Council as a heating promotional vehicle. Its program calls for a $3 million potential campaign chest, more than three times the amount being spent under the Heating Market Report program. Money is to be pledged by major companies and refiners in 20 key oil heat states, to be equalled by local dealers and distributors.

Laboratory Lots, Carboys, Tank Truck Tonnages . . .

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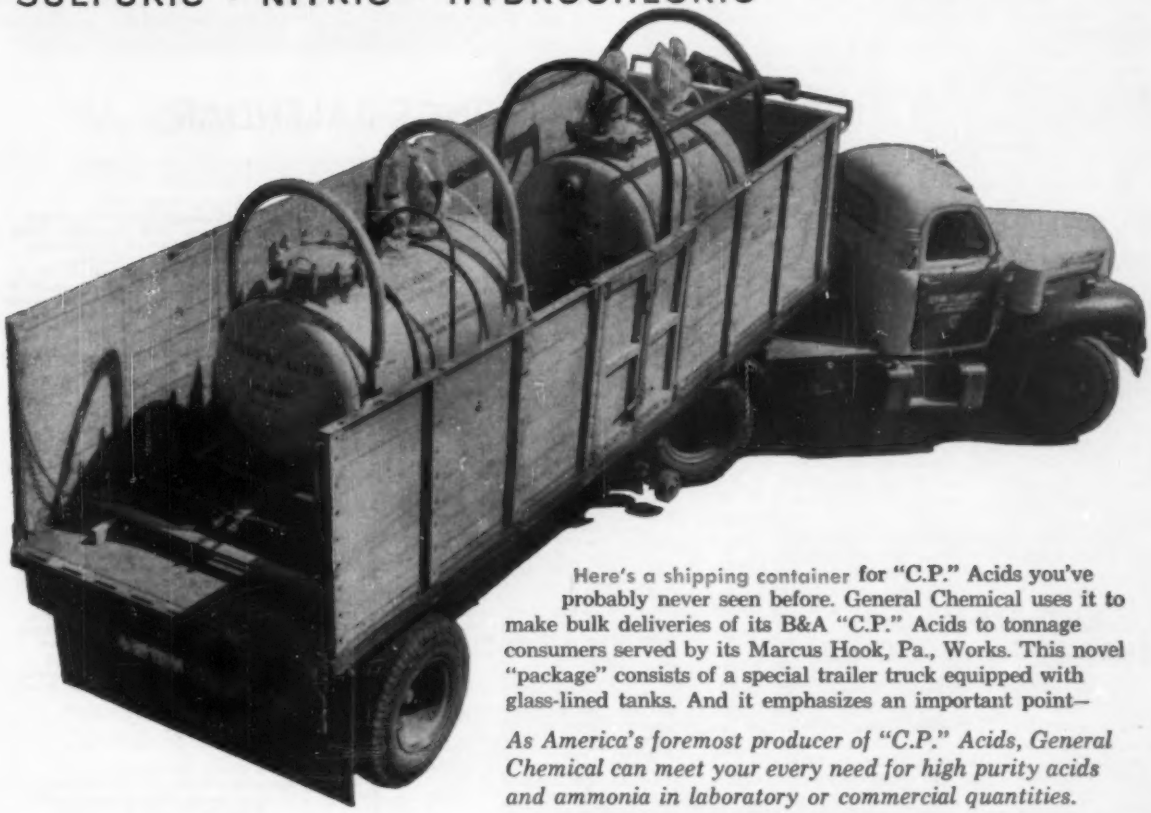

Here's a shipping container for "C.P." Acids you've probably never seen before. General Chemical uses it to make bulk deliveries of its B&A "C.P." Acids to tonnage consumers served by its Marcus Hook, Pa., Works. This novel "package" consists of a special trailer truck equipped with glass-lined tanks. And it emphasizes an important point—

As America's foremost producer of "C.P." Acids, General Chemical can meet your every need for high purity acids and ammonia in laboratory or commercial quantities.

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For all your "C.P." Acid needs, here is a *single* source—the *best* source! Specify B&A.

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What's Happening . . .

Carnegie Tech Announces Warner Prize Winners

Carnegie Institute of Technology's Chemistry department has announced the recipients of the Warner Prize in chemistry for 1958-59. **Michael C. Zerner**, of Kenberma, Mass., was awarded the Warner Sophomore Prize and **Michael R. Cocivera**, of Pittsburgh, was awarded the Warner Senior Prize.

The Warner Prizes were established by **Dr. J. C. Warner**, president of Carnegie Tech and former head of the Chemistry department.

The prize for sophomores consists of a three year membership in the Student Affiliate Chapter of the American Chemical Society and is awarded on the basis of scholastic record. The same requirements exist for seniors but the prize is given for both scholastic achievement and professional promise.

Air Pollution Meeting Features Oil's Role

Petroleum industry spokesmen played important roles at the National Conference on Air Pollution, November 18-20. Gulf Oil Corp.'s vice president, Dr. Jerry McAfee, spoke on accomplishments in air pollution control by the petroleum industry.

Gerald Fisher, pollution control coordinator for General Petroleum Corp., and Charles A. Jones, senior technologist for Shell Oil Corp., discussed air pollution sources, and several representatives of the automobile industry told of its achievements in the field.

The conference is held yearly to review the latest knowledge about the air pollution problem and how to handle it.

Lehigh University Gets $98,480 Research Grant

Three research grants have been given to the Institute of Research, Lehigh University, totalling $98,480. Two grants totalling $83,800 were made by the National Science Foundation for research work in physics. The third, for $14,680, is for the department of chemical engineering from Petroleum Research Fund of ACS.

Largest of the grants, $59,300 from the National Science Foundation, is for shock tube flow studies on boundary layers and theoretical interpretation of chemical reactions.

Lehigh received $24,500 from National Science Foundation for basic research on "The Relativistic Theory of Interacting Particles."

The $14,680 ACS grant is to support research on the thermodynamic properties of gas mixtures.

— Changing Times —

Nationalist government-owned **China Petroleum Co., Formosa, will supply 50,000 barrels of marine diesel fuel per month to U. S. Fleet** from 20,000-bpd Kaohsiung refinery at southern tip of island.

Cities Service has filed with Securities & Exchange Commission to **divide Arkansas Fuel Oil Co. into two separate companies.** Cities Service says it has **"exhausted all legal remedies to SEC order** that it give up majority interests or eliminate minority interests.

Army Corps of Engineers won't shift from coal to other fuels until considering possible economy in installing modern coal equipment, National Coal Association has announced.

Ford Motor Co. is stressing fuel economy in its 1959 models. Company claims car will **need oil change only each 4,000 miles** instead of previous 2,000 because of improved filter and crankcase—also, that **redesigned engine will save $1 per tank of gasoline.**

Union Carbide Plastics Corp. is the new name for Bakelite Co. The name Bakelite, in use for 50 years, will continue in use for U.C.'s synthetic resins.

National Safety Council says falls are most frequent source of accidental death in U.S., causing nearly 21,000 deaths per year. Auto accidents are No. 1 killer. Council says **workers are killed more often in off-the-job accidents than on.** Figures are 31,800 compared to 14,200.

Gulf Oil Corp. has formed **a new Crude Oil department** to sell, purchase and exchange crude in world-wide company operations.

MEETINGS CALENDAR

DEC.	
18–20	American Physical Society, Los Angeles.
26–31	American Association for the Advancement of Science, Annual Meeting, Washington D.C.
29–30	American Chemical Society, Division of Industrial and Engineering Chemistry, Christmas Symposium, Pittsburgh.
JAN. 1959	
12–14	National Association of Corrosion Engineers, Eastern Regional Meeting, Montreal, Quebec.
12–16	Society of Automotive Engineers, Annual Meeting and Engineering Display, The Sheraton-Cadillac Hotel and Hotel Statler, Detroit.
23	Natural Gasoline Association of America, Oklahoma Regional Meeting, Biltmore Hotel, Oklahoma City.
26–27	American Society for Engineering Education, University of Houston.
26–29	Plant Maintenance and Engineering Show, 10th Annual Show, Public Auditorium, Cleveland.
28–29	Midwest Welding Conference (Armour Research Foundation and Chicago Section of American Welding Society) at Illinois Tech, Chicago.
FEB.	
2– 6	American Society for Testing Materials, Committee Week, William Penn Hotel, Pittsburgh.
5– 6	Industrial Management Engineering Conference, Sponsored by Illinois Institute of Technology and Armour Research Foundation, Chicago.
11–13	National Association of Corrosion Engineers, Western Regional Meeting, Calgary, Alberta.
15–19	American Institute of Mining Engineers, Annual Meeting, Sir Francis Drake Hotel, San Francisco.
26–27	American Petroleum Institute, Division of Marketing, Lubrication Committee Meeting.
27	Natural Gasoline Association of America, Permian Basin Regional Meeting, Schorbaur Hotel, Midland, Texas.
MAR.	
1– 5	American Society of Mechanical Engineers, Gas Turbine Power Conference and Exhibit, Netherlands-Hilton Hotel, Cincinnati.
8–12	American Society of Mechanical Engineers, Aviation Conference, Statler Hotel, Los Angeles.
9–11	Midwest Gas Association, Annual Meeting, Hotel Fort Des Moines, Des Moines.
13	American Institute of Chemical Engineers and American Chemical Society, 6th Annual Joint Technical Meeting, Beaumont, Texas.
16–18	Western Petroleum Refiners Association, 47th Annual Meeting, Hilton Hotel, San Antonio.
MAR.	
16–20	National Association of Corrosion Engineers, 1959 Corrosion Show and 15th Annual Conference, Sherman Hotel, Chicago.
16–20	American Society for Metals, et al, 11th Western Metal Exposition and Congress, Pan-Pacific Auditorium and Ambassador Hotel, Los Angeles.
APRIL	
5–10	Instrument Society of America, Nuclear Congress, Cleveland Auditorium, Cleveland.
6– 7	Instrument Society of America, 2nd Annual Symposium on Chemical & Petroleum Instrumentation, St. Louis.
13–17	The 29th Annual Safety Convention & Exposition, Hotel Statler, New York.
15–17	National Petroleum Association, Semi-annual Meeting, Hotel Cleveland, Cleveland.
19–23	American Society of Mechanical Engineers, Oil and Gas Power Conference and Exhibit, Shamrock-Hilton Hotel, Houston.
22–24	Natural Gasoline Association of America, 38th Annual Convention, Baker and Adolpus Hotels, Dallas.
MAY	
4– 5	American Society of Mechanical Engineers, Maintenance and Plant Engineering Division Conference, Chicago, Edgewater Beach Hotel.
4– 6	American Petroleum Institute, Division of Marketing, Lubrication Committee Meeting.
5– 7	Purdue University's 14th Annual Industrial Waste Conference, Purdue Memorial Union Building, Lafayette, Ind.
14–23	International Petroleum Exposition, Tulsa.
18–20	Instrument Society of America, 5th Annual Symposium on Instrumental Methods of Analysis, Shamrock-Hilton Hotel, Houston.
27–29	American Petroleum Institute, Division of Marketing, Midyear Meeting.
JUNE	
1– 5	Fifth World Petroleum Congress Exposition, New York Coliseum, New York.
14–19	Society of Automotive Engineers, Summer Meeting, Chalfonte-Haddon Hotel, Atlantic City.
21–26	American Society for Testing Materials, Annual Meeting, Chalfonte-Haddon Hall, Atlantic City.

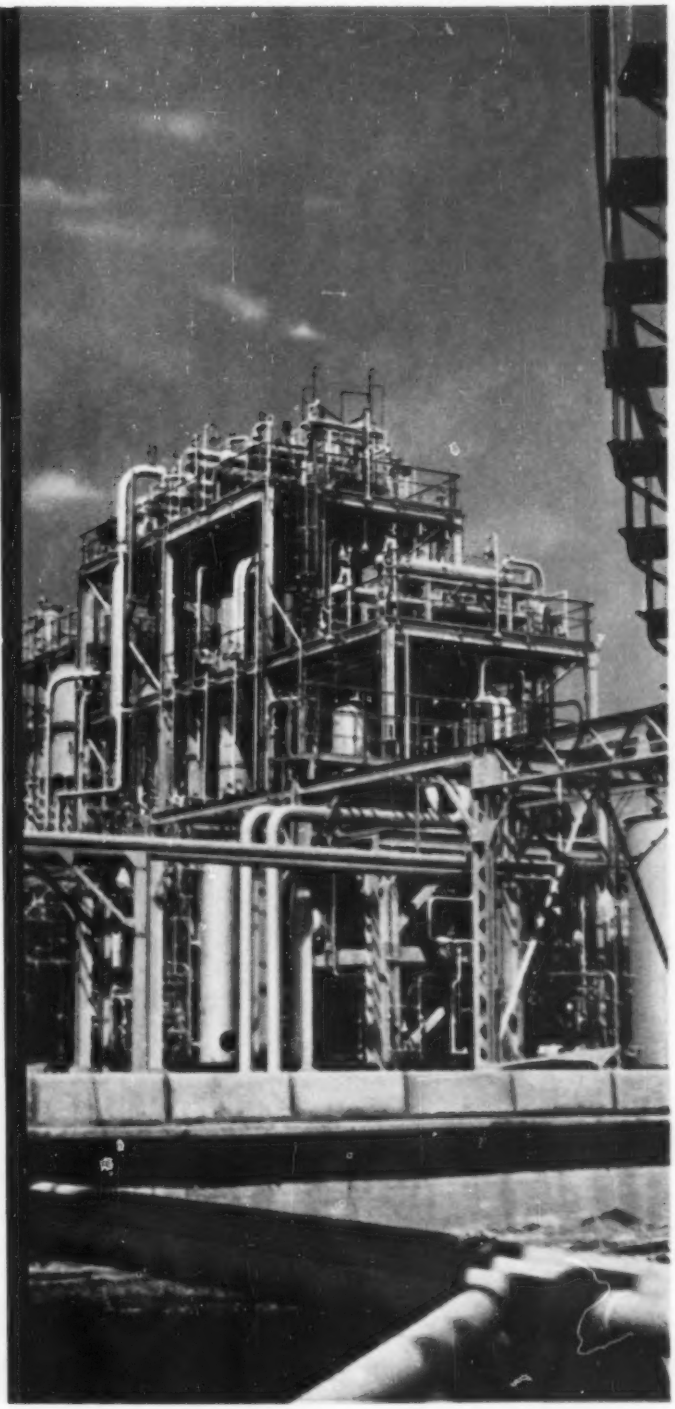
West to the Orient

NEW DESIGNS FOR NEW PRODUCTION RECORDS

With local demand running far greater than imported supplies, Nippon Petrochemicals Co., Ltd. called on Stone & Webster to design Japan's first Isopropyl Alcohol and Acetone plant. And within a few days of being placed on stream, this flexible, highly instrumented plant at Kawasaki has produced at a rate above designed capacity and purity. This is Japan's first petrochemical unit to set such a production record from the very start.

Such profitable installations require that production schedules and budgets be met, and possible operational difficulties be solved at the blueprint stage. Through Stone & Webster Engineering Corporation this skilled ability and experience is available for your next engineering project – whatever its type or size or location. Simply call or write our nearest office.

Stone & Webster adds profits to your project through engineering economies and extra plant efficiency.



4.4 million pounds of 99% IPA and 7.7 million pounds of 99.5% acetone per year are produced at this plant designed by Stone & Webster from processes developed by The Distillers Company Limited and British Hydrocarbon Chemicals Limited. Further facilities for ethylene and butadiene production are now being designed by Stone & Webster.

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Specifically: one processor had been performing his own turnaround service—using mechanical methods—at an annual cost of $315,000. The Dowell Service Engineer and his team performed the same service in 1/10 of the time at a cost of $2300. The savings in downtime alone amounted to $210,000.

If your maintenance and operating engineers do not know the profit possibilities with Dowell Service, ask them to get the facts for you. For specific information on how chemical cleaning can help your plant to greater profits, call the Dowell office nearest you. DOWELL—A SERVICE DIVISION OF THE DOW CHEMICAL COMPANY. Headquarters and research center, Tulsa, Oklahoma, with 165 offices and stations to serve you.

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What's Happening . . .

. . . *Among Men* in the Industry

Certificates of Appreciation Presented at API Meeting

"Certificates of Appreciation" were presented to 40 oilmen from all sections of the nation at the 38th annual meeting of the API. Those honored for long and valued service to the association and the industry, and the division or group of the API which awarded the certificates, are as follows:

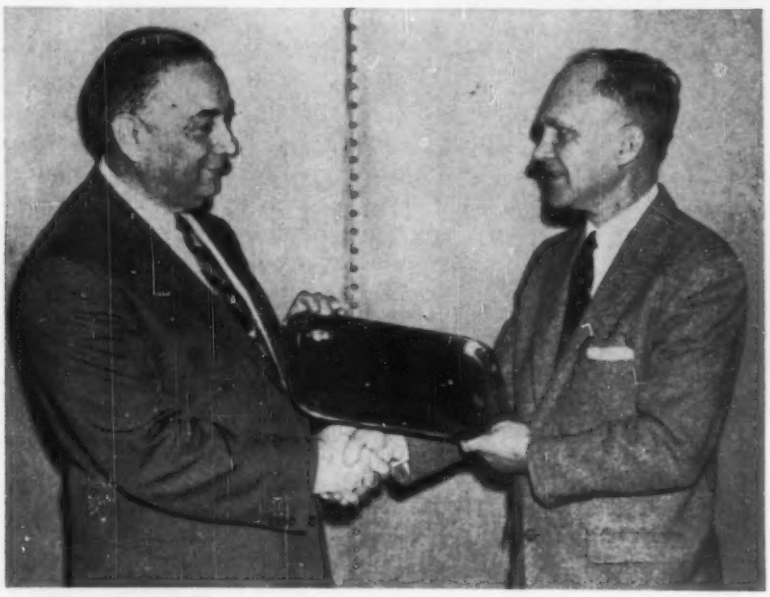
Division of Finance and Accounting: **Ralph A. Martin,** The Standard Oil Co. (Ohio), Cleveland;

Fundamental Research Committees: **Lloyd E. Elkins,** Pan American Petroleum Corp., Tulsa; **Theodore W. Nelson,** Socony Mobil Oil Co., Inc., New York; **W. D. Seyfried,** Humble Oil and Refining Co., Baytown, Texas;

Medical Advisory Committee: **Dr. Robert E. Eckardt,** Esso Research and Engineering Co., Linden, N. J.;

API Committee: **Oscar John Dorwin,** The Texas Co., New York; **Rayburn L. Foster,** Phillips Petroleum Co., Bartlesville; **Archie D. Gray,** Gulf Oil Corp., Pittsburgh; **Charles Z. Hardwick,** The Ohio Oil Co., Findlay, Ohio; **J. G. Jordan,** Shell Oil Co., New York; **William A. McAfee,** The Standard Oil Co. (Ohio), Cleveland; **R. L. Milligan,** The Pure Oil Co., Chicago; **Henry L. O'Brien,** Cities Service Co., New York; **Merrill H. Utley,** Standard Oil Co., (Ky.), Louisville;

Oil Information Committee: **W. A. Alexander,** Shell Oil Co., Denver; **W. A. Bourne,** Gulf Oil Corp., Toledo; **Charles R. Brown,** Tidewater Oil Co., San Francisco; **Fayette B. Dow,** National Petroleum Association, Washington, D. C.; **Richard D. Drysdale,** Sun Oil Co., Boston; **W. M. Johnson,** Shell Oil Co., New Orleans; **R. C. W. Jones,** E. I. du Pont de Nemours and Co., Inc., New York; **Harry J. Kennedy,** Continental Oil Co., Houston; **W. G. King, Jr.,** Richfield Oil Corp., Los Angeles; **Thomas W. Phelps,** Socony Mobil Oil Co., Inc., New York; **H. J. Potts,** Socony Mobil Oil Co., Inc., Philadelphia; **Harold E. Purdy,** Standard Oil Co. (Ind.), Kansas City; **J. O. Sanders,** The Texas Co., Atlanta; **J. L. Sewell,** Delhi-Taylor Oil Co., Dallas; **Charles E. Simons,** Texas Mid-Continent Oil and Gas Association, Dallas.



President Rudolph Cubicciotti, of the National Lubricating Grease Institute, presents an engraved silver tray to Lawrence C. Brunstrum, right, of Flossmoor, Ill. Brunstrum received the award in recognition of service and contributions to grease technology. He is in charge of research on greases and industrial lubricants at Whiting Research laboratories, Standard Oil Co. (Ind.)

Charles E. Anderson has been named manager of the Purchasing Planning division of Standard Oil Co (Ind.) Purchasing department. He joined Standard at its Whiting, Ind., refinery in 1947 as an inspection engineer in the Manufacturing department and in 1952 moved to Chicago general office. He transferred to the Purchasing department in 1954.

Anderson studied mechanical engineering at Texas University and the University of Colorado where he received a B.S. degree. He received a law degree from De Paul University law school and has taken graduate work at John Marshall law school.

John R. Suman and William P. Kliment have earned the highest award in the field of voluntary standards, from the American Standards Association. The two gold medals were presented to the recipients during the Ninth Annual Conference on Standards.

Suman, a retired vice president and a director and member of the executive committee of Standard Oil Co. (N. J.), and an honorary director of the API, has been awarded the Howard Coonley Medal "for his leadership role in the advancement of the national economy through voluntary standards." Active since 1925 in API, Suman worked in the development and application of standards for oil field equipment and practices.

William P. Kliment, engineer of standards, Crane Co., has been awarded The Standards Medal for his "indefatigable efforts and outstanding achievements in the practical development and application of voluntary standards." He has been active on more than one hundred standardization committees of several trade and professional societies, among them the Manufacturers Standardization Society of the valve and fittings industry, the ASA, ASTM, ASME, API and the American Welding Society.

The Howard Coonley Medal is awarded each year to a person of public stature who has served the voluntary standards movement through his position, practice, and example.

The Standards Medal is awarded yearly to an individual who has played an outstanding role in the practical work of developing and using national standards.

C. E. Kaddy, Jacob C. Muskin, and E. Roy Sweet have been elected partners in Singmaster & Breyer, New York metallurgical and chemical process engineers. The three have been with the firm for many years—Kaddy as construction manager, Muskin as chief structural engineer, and Sweet as manager of chemical engineering.

Singmaster & Breyer is affiliated with The Fluor Corp., Ltd.

Dr. Joseph L. Russell has been appointed director of engineering research for Scientific Design Co., Inc. In that capacity he will be responsible for new process development at the company's Research and Development center. He had previously

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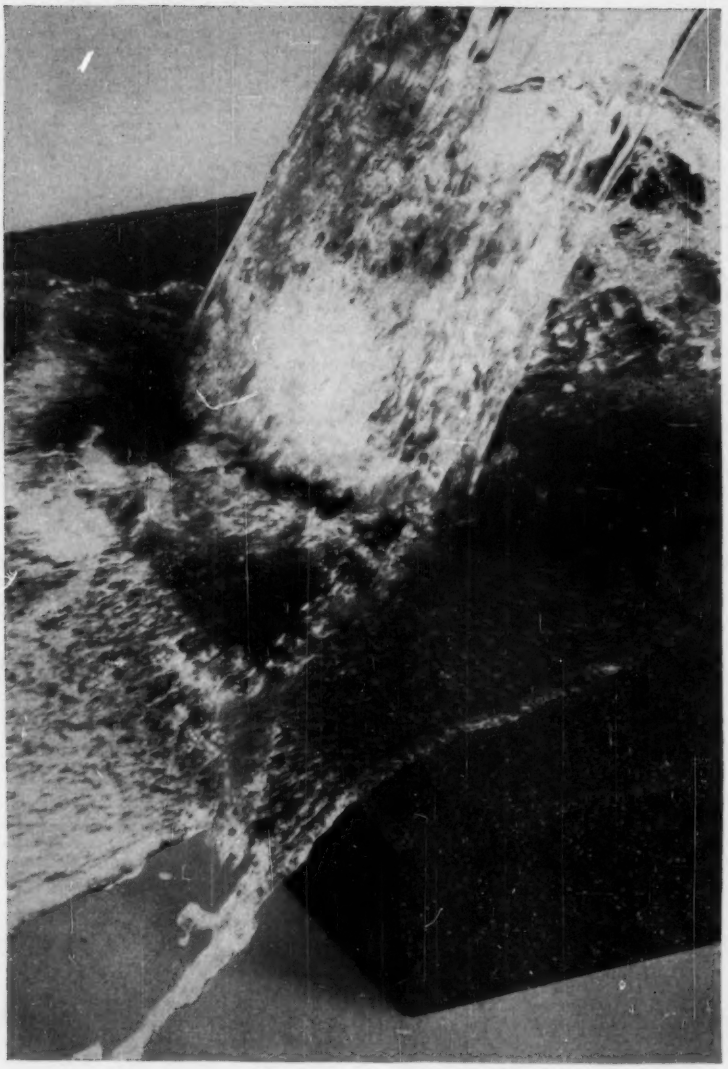

Whether you insulate building roofs and walls, piping or equipment, you can seldom anticipate *all* of the conditions to which your insulation will be exposed after installation. Humidity conditions change. Temperature control needs vary. Even the original use for insulated space or equipment may alter. That's why the ideal thermal insulation must give you a *combination* of key benefits . . . in order to serve satisfactorily under all possible conditions.

Most important, the ideal insulation must be impervious to water vapor as well as liquids—in order to insure constant performance under all humidity exposures. It should be proof against acids and acid vapors. It should be incombustible . . . dimensionally stable . . . impervious to vermin : . . strong enough for a variety of structural uses. Just one insulation—cellular glass—meets all of these qualifications.

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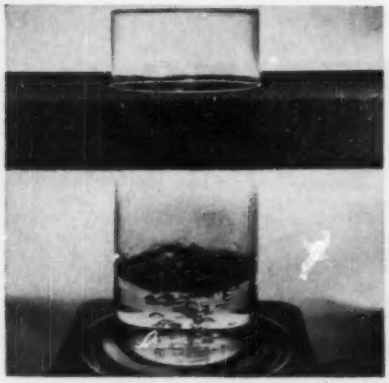
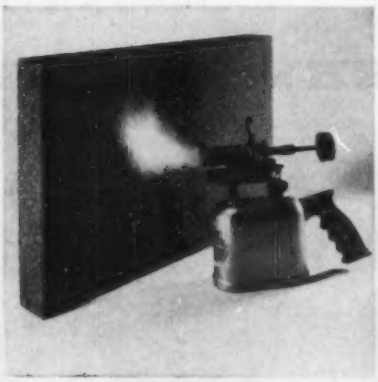
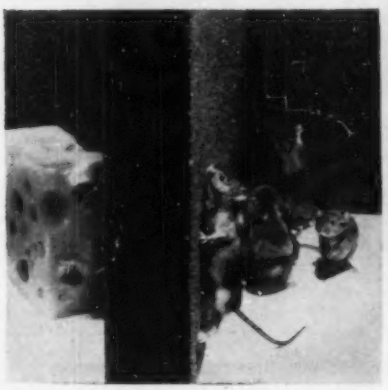


Moisture-proof! The minute liquid or vapor enters an insulation, it begins to lose its insulating value because moisture conducts heat. FOAMGLAS, a material composed entirely of sealed glass cells, is completely impervious to all moisture. Its K factor—measure of insulating performance—never varies.



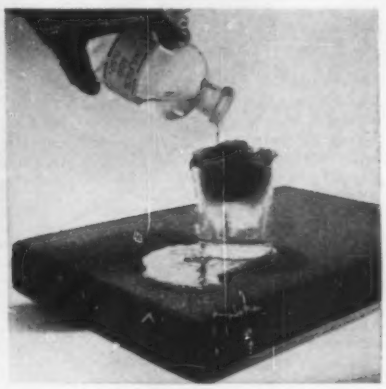
Can't Burn! Smoldering insulation in walls or roof of a building is a deadly fire hazard, hard to detect, difficult to control once detected. FOAMGLAS eliminates this hazard because it is the only insulation composed entirely of incombustible glass. This may even mean lower fire insurance rates in some cases.

Dimensionally Stable! Most insulations tend to warp, swell, shrink or slump after they are installed. This causes open joints in the insulation . . . insulation voids that create a serious loss of efficiency. There is no such difficulty with FOAMGLAS. This all-glass insulation always maintains absolute dimensional stability.



Vermin-proof! Most insulations offer no protection at all against vermin in food processing, storage or handling operations. Rats and other vermin gnaw right through them. FOAMGLAS, on the other hand, affords an excellent vermin barrier. Its all-glass composition offers no food or nesting materials for vermin.

Strongest! FOAMGLAS has a compressive strength of over 7 tons per square foot (av. ult.). It forms a solid base for built-up roofing. It makes possible the placing of insulation beneath heavily loaded floors. And high strength FOAMGLAS permits such cost saving design innovations as free standing walls and partitions.



Acid-proof! There is often a lot of acid around a processing operation. Even the atmosphere around processing plants frequently has a high acid content. Acids will attack and destroy most thermal insulating materials, but they won't harm FOAMGLAS. This unique all-glass material is completely impervious to all common acids.

CORNING

For more data on advertised products, use Readers' Service Cards, last page.

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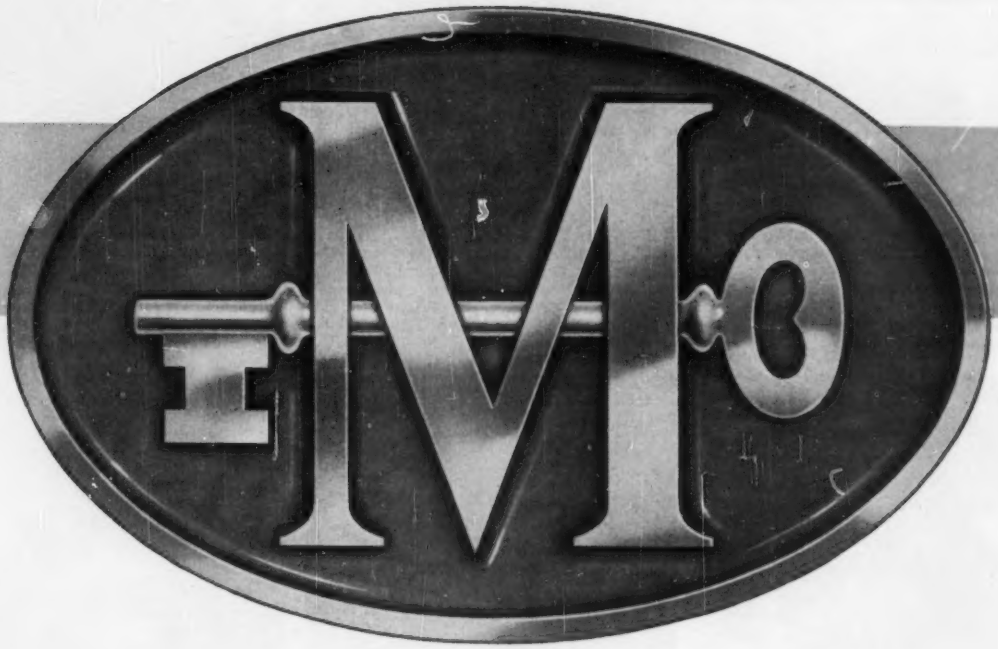

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been with the Polychemicals Research department of Dow Chemical Co.

Dr. Russell received his B.S. degree in chemical engineering at the University of Kansas, and his Sc.D. degree at Massachusetts Institute of Technology. At MIT he held the Du Pont and Eastman Kodak fellowships. He also served as an instructor at MIT and at Northeastern University.

Dr. Russell is a member of AIChE, to which he has contributed several papers.

Watt H. McBrayer has been named manager of industrial relations for Cities Service Oil Co. (Del.). He has been doing industrial relations work for Cities Service since 1926, and was appointed manager of industrial relations in 1941. His election to the directorate of Cities Service Oil Co. (Del.) was announced earlier this year.

McBrayer joined the company in 1950 in the Legal division, assigned to industrial relations work. He transferred to the Industrial Relations department in 1955 as assistant to the manager, and has held this position since. Before joining Cities Service, McBrayer was with a Pittsburgh industrial relations consulting firm.

Dr. Carl H. Samans is one of three men to receive the annual Merit Award offered by the Chicago Technical Societies Council November 12. He is associate director of engineering research for Standard Oil Co. (Ind.) and has a B.S. degree from Rensselaer Polytechnic Institute, and M.S. and Ph.D. degrees in metallurgy from Yale University.

Gordon R. Henderson has been elected president and director of Catalytic Construction of Canada, Ltd. In 1925 he received a B.S. degree in civil engineering from Queen's University, and worked thereafter in various engineering capacities with a number of companies.

Henderson

In 1932, he joined the engineering staff of Shell Oil Co. of Canada as chief engineer of its Montreal refinery. In 1940, he was placed in charge of a large refinery in Heysham-Lancashire, England. In 1942 he was with Polymer Corp. as a petroleum engineer, and later as chief engineer, a position he held until 1951 when he became general manager of Catalytic's Canadian activities. Henderson has also been general manager of Sun Oil Co., Ltd., Sarnia refinery.

J. L. Hoelscher, maintenance superintendent at Ohio Oil Co.'s Robinson, Ill., refinery, will transfer to the general office, Findlay, Ohio, as senior engineer on the refining engineering manager's staff. He has served at the Robinson refinery since joining Ohio Oil in 1945. Hoelscher is a graduate of Ohio State University.

Vernon Frost is recipient of CNGA's Meritorious Service Award for 1958. Other "Sam" award winners were **L. V. Leonard**, Shell Oil Co.; **Don B. Johns**, Standard Oil Co. of Calif.; **Guy Corfield**, Los Angeles Gas and Electric Co.; **Floyd E. Bradley**, CCMO Gas department; and **L. M. Windle**, Richfield Oil Corp.

R. P. Corlew has been appointed manager of refineries for Richfield Oil Corp. He will direct operations at Richfield's 130,000-bpd refinery at Watson. A graduate of the Colorado School of Mines, he started with Richfield as a technical assistant in 1938 and has since been process engineer, superintendent of light oil operations and assistant manager. **E. H. Reynolds**, formerly superintendent of operations, has been named assistant manager of refineries—Operations. **Frank J. Fontana**, formerly chief engineer, has been appointed assistant manager of refineries—Maintenance and Construction.

Robert H. Rowland of San Francisco has been named manager of the Hawaiian refinery of Standard Oil Co. of Calif., Western Operations, Inc. He graduated from the University of Michigan in 1938 and joined the engineering staff at Standard's Richmond, Calif., refinery the same year. In 1947 he was appointed superintendent of the Perth Amboy, N. J., refinery of California Oil Co., and was named manager there in 1950. He returned to Standard's home office at San Francisco in 1958.

Marvin L. Hayes has become an administrative assistant in the office of Chairman **Frank O. Prior**, Standard Oil Co. (Ind.). With the company for 18 years, he has been assistant to the corporate secretary.

Hayes joined Standard in 1940 as a clerk at St. Joseph, Mo. He came to the general office in Chicago in 1949, and became a senior analyst in the procedures and reports study unit, Comptroller's department, in 1952. He was made supervisor of cash estimates and banking in the Treasurer's department in 1955, and was appointed assistant to the corporate secretary in 1957.

Arthur E. Bone, president of the Liquefied Petroleum Gas Association, has been appointed chairman for standing committees and sections for 1958-59. He named 18 LPGA members to head the committees and six to chairmanships of the six sections representing the major industry segments of the association. Each chairman becomes a member of the LPGA board of directors and serves for one year.

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Men in the Industry . . .

Warren C. Wilson has been appointed product manager for lube oil additives by Esso Standard Oil Co., New York. He has been assistant to the manager of Esso's Bayway refinery at Linden, N. J. He joined Esso at Bayway in 1933 and served there until 1955, rising to assistant general superintendent. A year later, he transferred to the Manufacturing department in New York to coordinate safety activities at all Esso refineries, and returned to Bayway last April as assistant to the manager.

Raimundo J. Galletti has been transferred from chief of the Argentine government Oil Fields Commission in New York to an executive position in the home office of Yacimientos Petroliferos Fiscales (YPF) in Buenos Aires, Argentina. His former post in New York was assumed by **Gregorio A. Cariglino.**

F. E. Rosenstiehl has been elected 1959 president of the National Lubricating Grease Institute at its 26th annual meeting, in Chicago. He is with The Texas Co. **H. A. Mayor, Jr.**, Southwest Grease and Oil Co. is vice president, **Dr. J. V. Starr**, Esso Standard Oil Co. is secretary and **A. J. Daniel**, Battenfeld Grease and Oil Co. is treasurer. Elected to the NLGI board of directors were Mayor, **S. C. M. Ambler** of British American Oil Co., **T. W. Binford** of D-A Lubricants Co., **E. W. Campbell** of Gulf Oil Corp., **R. Cubicciotti** of L. Sonneborn Sons, **A. G. Griswold** of Cities Service Oil Co., **F. R. Hart** of Standard Oil Co. (Calif.), **C. L. Johnson** of Jesco Lubricants Co., **W. A. Magie II** of Magie Brothers Oil Co., **A. S. Randak** of Sinclair Refining Co. and **T. F. Shaffer** of Shell Oil Co.

Dr. John J. McKetta, Jr., University of Texas professor recognized in American Men of Science and Who's Who in Engineering, has been appointed Chemical Engineering department chairman. He has served on the University staff 12 years, and is the third chemical engineer in Texas to hold an AIChE national directors post.

McKetta was named to succeed the late **Dr. Kenneth A. Kobe**, who helped develop the department through his teaching and research over a 17-year period. Drs. Kobe and McKetta collaborated on numerous research and writing projects. They were editors of a book on "Advances in Petroleum Chemistry and Refining," recipients of an ACS grant to study the "deviation of natural gases from ideal gas behavior," and presented a paper at an ACS regional meeting in Tulsa, which received requests for a "repeat performance" at the national meeting in Chicago last September.

Dr. McKetta holds degrees from Tri-State College and the University of Michigan, of which he is a "distinguished alumnus." Before joining the University staff he was with Wyandotte Chemical Co. and the C. B. Schneible Co. He is a member of numerous honorary and professional societies and is chairman of the Editorial committee, PETROLEUM REFINER.

G. Boyd McConkey and John H. Smith have been named assistant directors in the Engineering division of Sun Oil Co.'s Research and Engineering department.

Five separate sections and their chiefs

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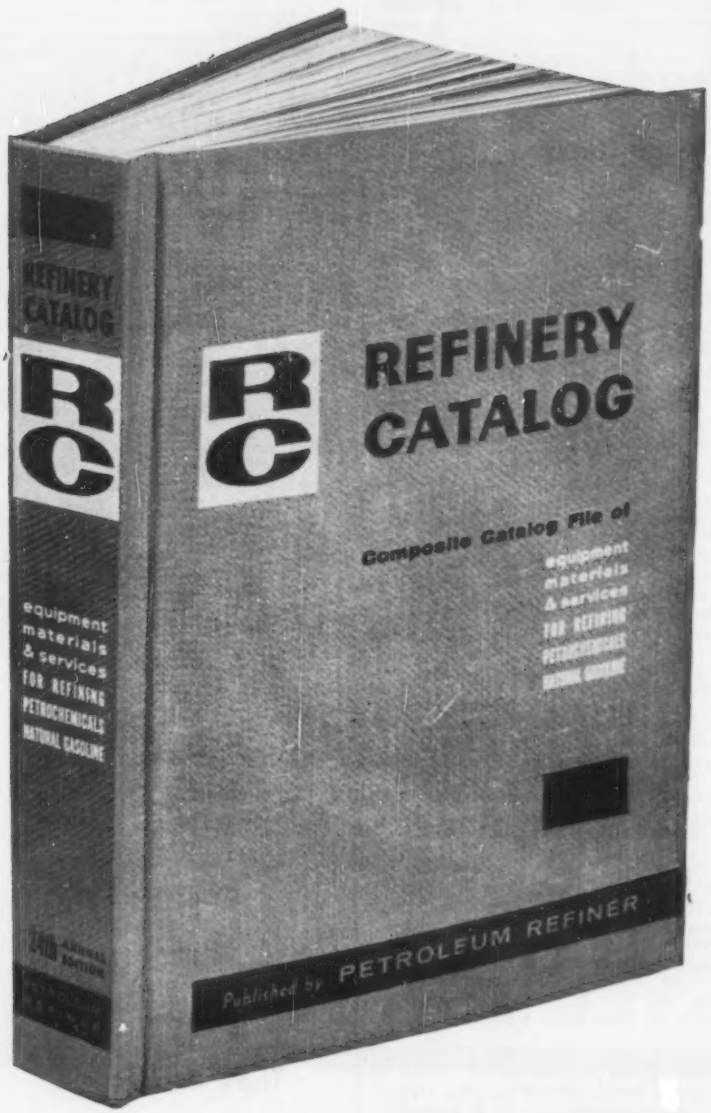

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For more data on advertised products, use Readers' Service Cards, last page.

Men in the Industry . . .

have been named. They are: **Joseph F. Hearn,** Project Engineering; **William H. Davis,** Process Engineering; **George E. Cook,** Design and Drafting; **Edward J. Nopper,** Administration; and **Joseph E. Garney,** Metallurgical Engineering.

McConkey received a B.S. degree in chemical engineering from Drexel Institute of Technology in 1936. He began his career as a development engineer in the Research and Development division at the Marcus Hook, Pa., refinery.

Smith, a project engineer with the Engineering division since 1942, joined the company in February, 1929. He received engineering training at Drexel Institute of Technology and the University of Pennsylvania, and is a registered professional engineer in Pennsylvania.

R. C. Adam will become manager of economics for Magnolia Petroleum Co. January 1. He will move to Beaumont, Texas, from Dallas. A graduate of the University of Arkansas, Adam joined Magnolia in 1946, and has been operations manager at the company's Beaumont refinery since 1956.

E. W. Allen, executive vice president of Wilshire Oil Co. of Calif., has become vice president in charge of marketing, in addition to his present duties. **Mark E. Houser** has been appointed director of manufacturing and will assume refinery activities formerly handled by Allen. He will also assume full responsibility for the Refinery and Pipeline departments and will coordinate economic research for present and future operations.

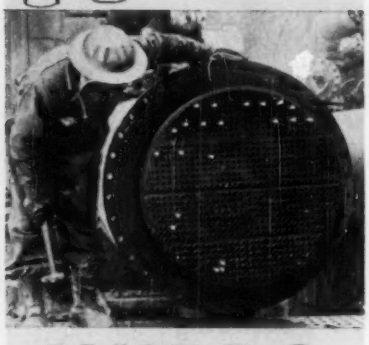
Keith E. Lorentzen has been named a project chemist Whiting Research laboratories, Standard Oil Co. (Ind.). He has carried out research in new and improved methods for analyzing petroleum products. Dr. Lorentzen has a Ph.D. degree in chemistry from Pennsylvania State University.

Emil M. Banas will also be a project chemist. He has carried out extensive research in such physical methods of analysis as x-ray and spectroscopy. He has a Ph.D. degree in physics from the University of Notre Dame.

Walter W. Frank has been named a project automotive engineer. He has carried out research and development on improved petroleum products, particularly lubricants. Frank has a B.S. degree in mechanical engineering from Purdue University and a M.S. degree in business administration from Harvard University.

R. D. Patch, former head of the Petroleum Products division at the Baton Rouge refinery of Esso Standard Oil Co., will join the Refining Coordination department of Standard Oil Co. (N. J.), Esso's parent company, on January 1. He will be regional coordinator for refining for the Eastern hemisphere, succeeding **Briar Mead,** who is retiring. During 24 years at the Baton Rouge refinery, Patch served as head of the Process Engineering department, coordinator of government projects during World War II, head of the Chemical Products division, and petroleum-products manager.

J. R. Fleming has joined the Athens, Greece office of George Armistead and Co. as assistant manager. The Armistead ogranization is the technical advisor to the Greek government in connection with the recently erected 30,000-bpd refinery



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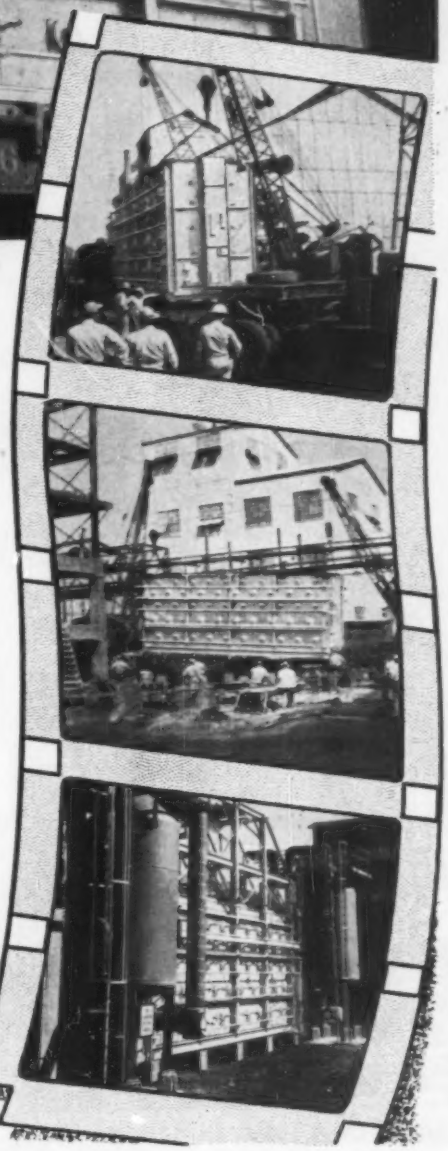
*For standard thermocouples and lead wire, write for Pyrometer Accessory Catalog.

Selas prefabrication saves time and money at job-site

After final inspection, the completed Selas Gradiation Heater is securely anchored on flatcar for shipment. Stack and convection sections are in adjoining car.



Upon arrival at job-site, cranes allow flatcar to be slipped out, Lo Boy slipped in.

The heater is lowered onto prepared foundations.

Convection and stack sections are installed; connection to process and fuel gas piping completes job.

SELAS prefabrication means much more than the accepted definition of prefabrication: it is *shop-assembly*. In capacities as large as 45 million Btu/hr coil duty, Selas Gradiation® Heaters are *complete* when they are shipped out: burners, brickwork, arch tiles are in place; manifold piping is attached and intact, complete with flanged connections; stacks and ducts completely insulated. Heating coils can be shipped installed or delivered to job-site, pre-assembled on tube supports, as desired.

In terms of field effort, Selas *shop-assembly* means complete erection of sub-assemblies on job-site foundations in less than eight hours!

Whatever your needs—*shop-assembly* or field-assembly—Selas Gradiation Heaters will give you longer "on-stream" periods, high conversions and selectivity, Zone Control of heat input, uniform heat distribution on the entire tube surface which extends tube life. Send for Bulletin 75 "Gradiation Heating for Petroleum and Chemical Processing."

Gradiation is a registered trade name of Selas Corporation of America.

SELAS
CORPORATION OF AMERICA

DRESHER, PENNSYLVANIA
HEAT AND FLUID PROCESSING ENGINEERS
DEVELOPMENT . . . DESIGN . . . CONSTRUCTION

For more data on advertised products, use Readers' Service Cards, last page.

Men in the Industry . . .

at Aspropyrgos. Fleming, formerly chief process engineer for Neches Butane Products Co., Port Neches, Texas, will deal with process engineering on the new refinery project.

David P. Martin has been appointed chief engineer at the East Chicago, Ind., refinery of Cities Service Oil Co. **D. J. Stover** will succeed him as group process supervisor there. Martin joined the company in 1942 and has held several plant positions. Stover served more than 21 years in the Refining division.

J. W. Alliston and T. M. Newsom have been named senior supervising engineers in the Technical division at Humble Oil & Refining Co.'s Baytown, Texas, refinery. Alliston supervises the Solvents section, and Newsom the Petrochemicals section. Each holds a B.S. degree in chemical engineering, Alliston from Texas A & M College, and Newsom from The University of Texas.

S. H. Coleman has been promoted to staff engineer, Technical division. He handles mechanical engineering design projects involving layout of new equipment, design of piping systems and pressure vessels, and the installation of machinery. He has a B.S. degree in electrical engineering from Texas A & M.

William B. Fenwick has been named Philadelphia division manager for American Oil Co. He has been with Amoco since 1946, serving as assistant Philadelphia division manager since 1954.

J. Howard Corry has been named manager of the Heavy Fuel Oil department in New York, succeeding **H. J. Wylie.** Corry joined Amoco in 1946 and was named assistant manager of heavy fuel oil sales in 1957.

Elmer O. Mattocks, director of the Technical Services department, American Petroleum Institute, was presented with an Award of Merit at the American Gas Association's 40th annual meeting. He was one of a group of engineers given the citations by AGA's Operating section. He was honored for many years' service on the committee on LP-Gas Utility Code, and the committee on Chemical Engineering.

Henry C. Frost has been named president of the Instrument Society of America. **Glen G. Gallagher,** vice president, ISA Standards and Practices department; **Thomas C. Wherry,** vice president, ISA Technical department; **John A. See,** district vice president; **Charles A. Kohr,** district vice president; **Howard W. Hudson,** treasurer; and **John Johnston, Jr.** president-elect-secretary. In addition, **William G. Brombacher** was elected to honorary membership in the ISA.

Frost

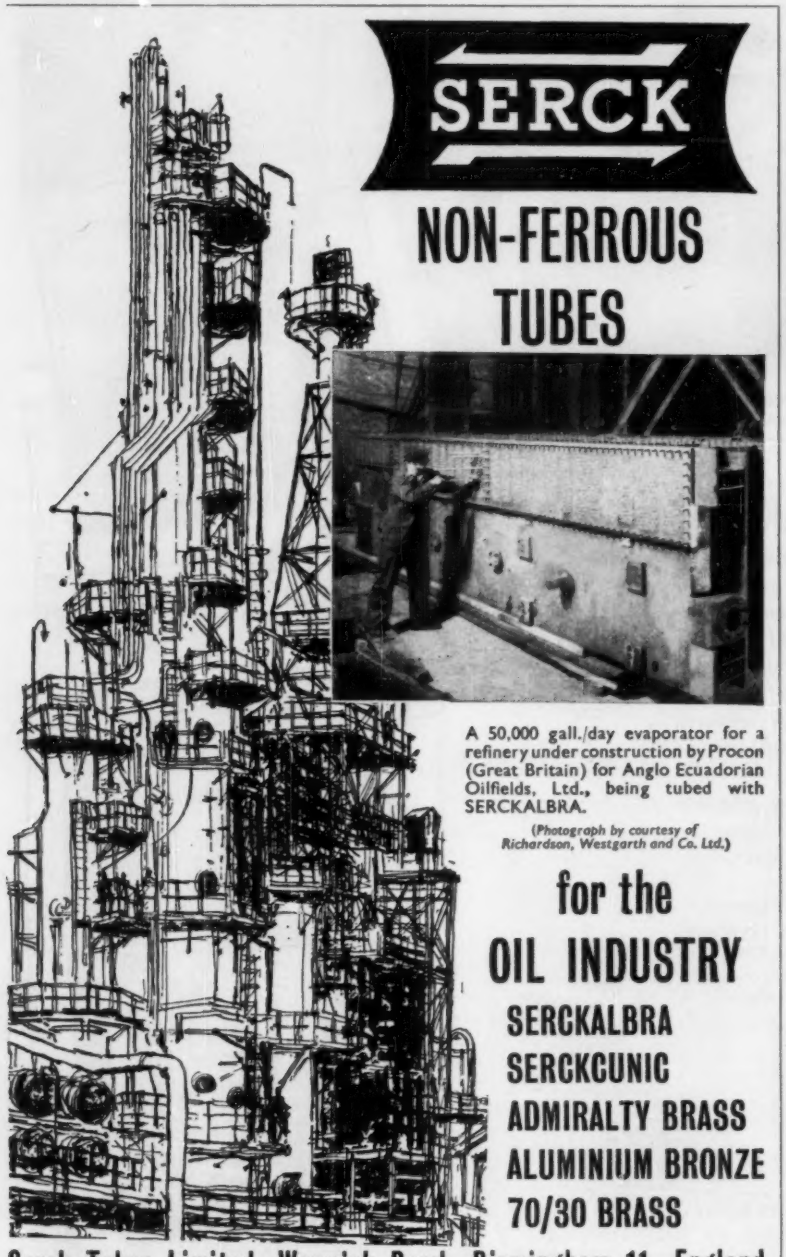
Frost is assistant chief engineer with Corn Products Refining Co., Chicago.

Ti-Kang Kwei has joined Whiting Research laboratories, Standard Oil Co. (Ind.). He will conduct petrochemical research. Dr. Kwei obtained his B.S. degree at Chiao-Tung University (China), his M.S. degree at the University of Toronto, and his Ph.D. degree in chemistry at the Polytechnic Institute of Brooklyn. He was formerly with Plastic Film Corp., Plainfield, N. J.

Dr. Raymond L. Betts has been appointed research associate at Esso Research and Engineering Co. Dr. Betts, whose field is process information research in the firm's Technical Information division, has been with Esso since 1937. Until last year when he transferred to the technical information unit, he was in the Process Research division, doing asphalt research. He earned a Ph.D. degree at Columbia University, and a M.S. degree from Oxford University. His B.S. degree is from Mount Allison University, Canada. He is a member of ACS.

Dr. L. Reed Brantley, head of the Chemistry department at Occidental College, Los Angeles, has been named visiting scientist at Lehigh University through a petroleum research fund award of ACS. He will work with the Lehigh chemistry staff during the coming year. Licensed as a chemical engineer in California, he has done research work in high temperature chemical equilibrium, chemistry of fluorine oxide, principles of adhesion, and environmental protective coatings.

Dr. Brantley, author of numerous pub-


SERCK
NON-FERROUS
TUBES
A 50,000 gall./day evaporator for a refinery under construction by Procon (Great Britain) for Anglo Ecuadorian Oilfields, Ltd., being tubed with SERCKALBRA.
(Photograph by courtesy of Richardson, Westgarth and Co. Ltd.)
for the
OIL INDUSTRY
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ADMIRALTY BRASS
ALUMINIUM BRONZE
70/30 BRASS
Serck Tubes Limited, Warwick Road, Birmingham 11, England

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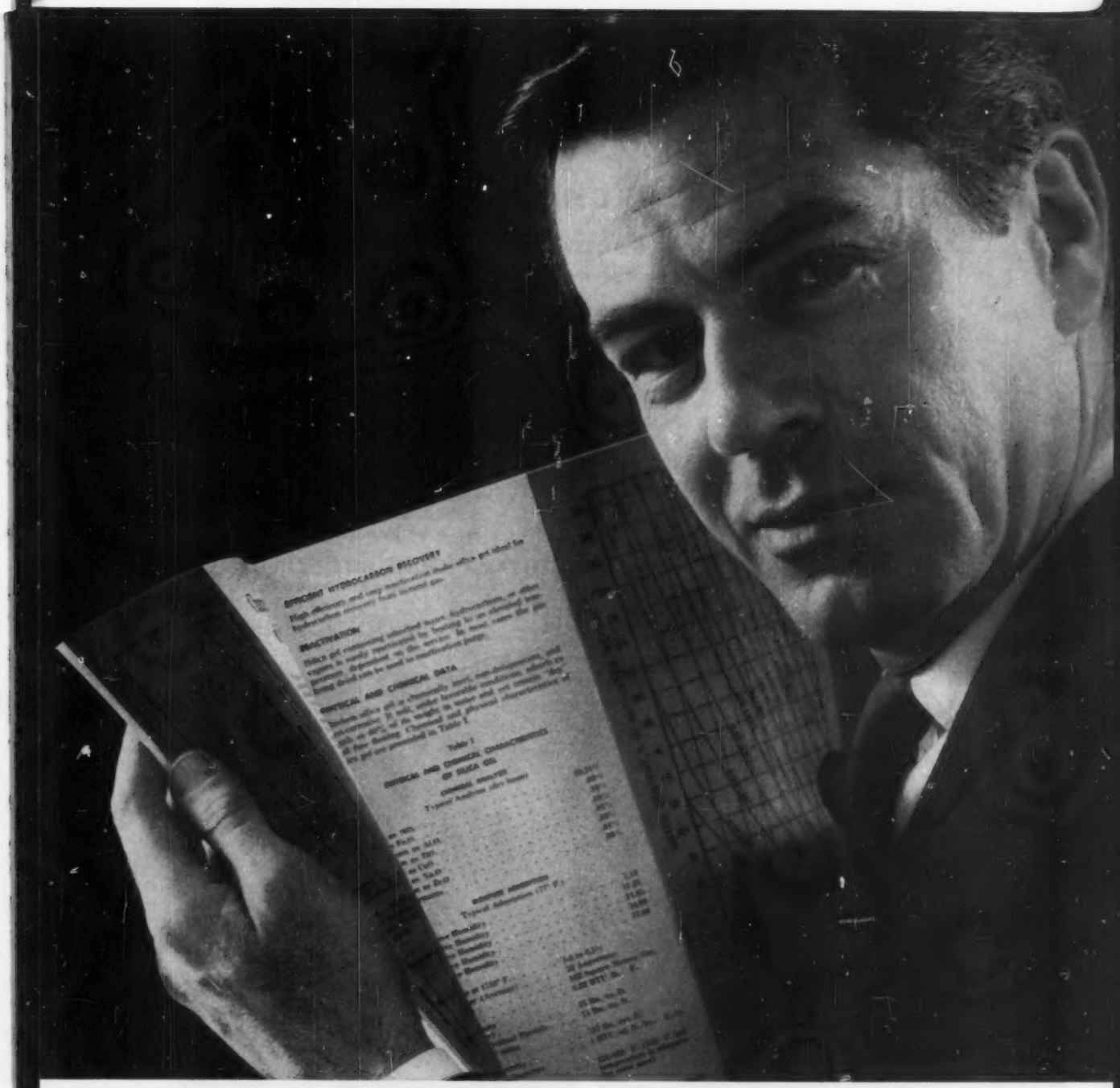


New from Davison . . . Technical Bulletin 202 on adsorption and dehydration with silica gel

If you have anything at all to do with air and gas dehydration, you'll want this 20-page, well-illustrated technical bulletin.

Here, in text and graph form, is a wealth of valuable, up-to-date technical data on: characteristics of silica gel; fundamentals of adsorption and dehydration; natural gas dehydration; recovery of hydrocarbons from natural gas; compressed air dehydration; atmospheric dehumidification; dehydration of industrial gases; special types of silica gel; and other applications of silica gel. The data presented are based on reliable laboratory and field tests.

We're sure you'll find Technical Bulletin 202 of great assistance in your everyday work. To receive a copy, write to us on company letterhead.

W. R. GRACE & CO.
DAVISON CHEMICAL DIVISION
BALTIMORE 3, MARYLAND

THERE'S ONLY ONE

OIL SUCTION AND DISCHARGE HOSE LIKE THIS!

CRUSHPROOF . . . LEAKPROOF . . . FLEXIBLE FOR VOLATILES AND GASES

Pioneered and performance-proved for more than one-quarter of a century by Penflex there has never been a suction and discharge hose like this for long service and trouble-free conveying of volatiles and gases.

This Penflex O. S. & D. Hose stands pressures to 600 psi . . . is stainless steel lined for rugged flexibility . . . covered with tough rubber for leakproof security. It is lighter in weight than any other comparable competitive hose . . . easy to handle with swivel flange that allows installation in any position without turning entire hose to meet bolt holes. End fittings are made of steel to meet specifications of refinery engineers.

Penflex Suction and Discharge Hose is used by leading industries throughout the nation for all-purpose duty. It is the proved and approved all-purpose hose for oil, gasoline, solvents, corrosive chemicals and other volatiles and liquids. Available in sizes 2" to 12" I.D. in galvanized steel, stainless steel and bronze pressure carrier. Write for technical data sheet.

PENNSYLVANIA FLEXIBLE METALLIC TUBING COMPANY
7207 Powers Lane, Philadelphia 42, Pa.

THE ORIGINAL ALL-METAL, PLUS RUBBER OIL SUCTION AND DISCHARGE HOSE PIONEERED BY PENFLEX

Men in the Industry...

lished articles, is president-elect of the division of Paint, Plastics, and Printing Ink Chemistry of ACS and chairman of its committee on chemical education. He has M.S. and Ph.D. degrees from the California Institute of Technology.

Donald F. Wishart, former chief project engineer, Chemical division, Boston, has been named engineering manager of Stone & Webster Engineering N.V., recently formed subsidiary in the Netherlands. He attended the Glasgow & West of Scotland Technical College before coming to the U. S. He joined S&W in 1926 as a draftsman and from 1948 until his new assignment, he supervised various major projects, including many foreign assignments. At one time he was acting managing director of S&W's British subsidiary.

–DEATHS–

Dr. Kenneth Albert Kobe, outstanding member of the University of Texas Chemical Engineering department for 17 years, died in Austin, Texas, November 2 of a cerebral hemorrhage. Funeral services were held in Austin with burial in Minneapolis. Dr. Kobe was a specialist in submurged combustion process and thermodynamics. He joined the University faculty in 1941 after teaching ten years at the University of Washington. A native of Osakis, Minn., he received B.S., M.S. and Ph.D. degrees from the University of Minnesota, of which he was named a distinguished alumnus in 1955. He held seven U. S. and three Canadian patents.

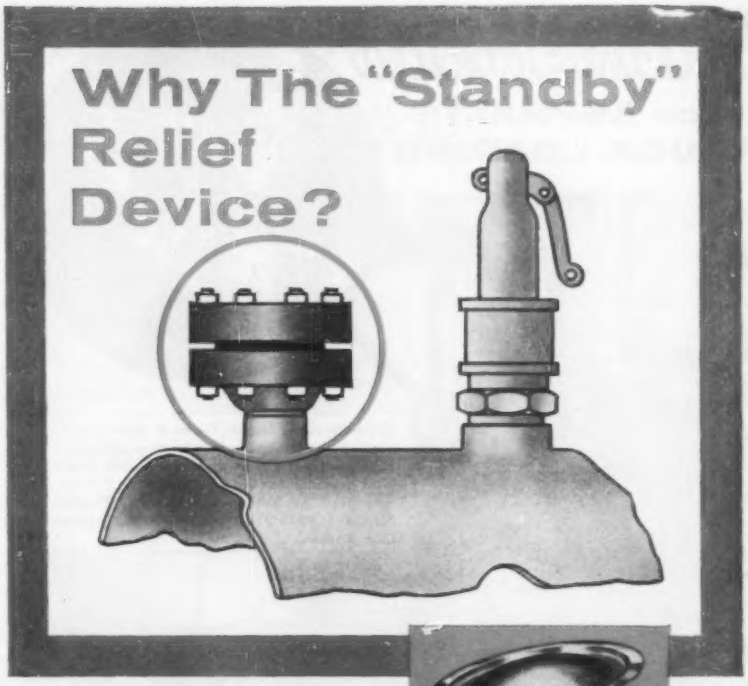
Dr. Kobe was active in promoting educational porgress between petrochemical industries and engineering schools. He was author of three books and more than 200 publications in scientific, technical and trade journals. This year he and Dr. John J. McKetta, Jr., chairman of PETROLEUM REFINER's editorial committee, edited the first volume of a series on "Advances in Petroleum Chemistry and Refining." He was a consultant for several oil and chemical companies, including DuPont Ammonia Corp., Seattle Gas Co., Manganese Products Co. and Submerged Combustion Co. He served in the U. S. Army Chemical Corps from 1942-44, and was a lieutenant colonel in the U. S. Air Force Reserve.

Dr. Kobe was a member of ACS, AIChE, and American Society for Engineering Education. In 1955 he was named national president of Omega Chi Epsilon, honorary chemical engineering fraternity.

C. Gilbert Collingwood, 60, of New Orleans, formerly manager of retail and jobber sales in Gulf Oil Corp.'s New York Sales division, died Saturday in New Orleans after a fall.

A graduate of Northwestern University, he joined Gulf in 1934 as a motor oil supervisor in the New York division office.

Elwood K. Pierce, Sr., 63, vice president and manager of the Houston office, The Wm. Powell Valve Co., died Sunday, November 9, while enroute to Chicago for the API meeting. He became ill on the plane, and passed away during the hurried trip from the Chicago airport to the hospital.



The BS&B *Safety Head* Takes Over Under Abnormal Conditions

Your relief valve may need a helping hand.
The double protection provided by this relief valve – BS&B Safety Head combination is ideal when—

- **The nature of the pressurized fluid may cause malfunction of relief valve.**
- **Instantaneous over-pressure occurs due to abnormal heat or regulating conditions.**

When pressure-relief requirement is greater than the discharge capacity of the valve, the BS&B Safety Head provides an instantaneous, unrestricted opening.

Thousands of pressure systems are now protected with the added security of BS&B Safety Heads.

BS&B Engineers will be glad to evaluate your pressure system for application of the correct BS&B Safety Head.

Write, Wire or Phone...

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Safety Head Division, Dept. 2-F12
7500 East 12th Street
Kansas City 26, Missouri
Telephone: BEnton 1-7200

For more data on advertised products, use Readers' Service Cards, last page.

"Steam Jacketed" for ASPHALT TRUCK LOADING

Close-up view, above, shows 4" Barco "Jacketed" Ball Joint on asphalt loading arm. Note counterweight extension on joint. This single joint provides for 360° vertical swivel movement and 30° horizontal flexibility. (Photos: PHILLIPS PETROLEUM COMPANY, Kansas City, Kansas)

BARCO Flexible Ball Joints

Here is another of the numerous refineries that are now using Barco's new STEAM JACKETED Flexible Ball Joints in piping lines handling asphalt. Steam heat makes it possible to load trucks in a fraction of the time otherwise required. Pumping loads and strain on pipes are reduced. Messy handling conditions, use of live steam jets, and the possibility of stopped up lines are also eliminated.

Barco produces the ONLY complete line of "jacketed" flexible joints that can cope with such tough loading conditions. Users report savings running into thousands of dollars for time saved and simplification of piping requirements. These permanent, maintenance-free, labor-saving installations eliminate the problem of rapid deterioration and frequent maintenance encountered with hose.

For recommendations on how to use Barco Flexible Ball Joints, ask for a Barco engineering field representative — located in principal cities.

FEATURES

COMPLETE LINE — Barco Steam Jacketed Flexible Ball Joints are now offered in 2", 3", 4" and 6" sizes.

TO MEET YOUR NEEDS — Straight and angle; screwed and flanged styles, or welding ends. Steel casing.

FLEXIBILITY — The ball provides more than 30° total angular movement in any direction.

VERSATILE — For handling asphalt, molten sulphur, and other heavy materials. Heat speeds flow; cuts loading time.

ENGINEERING RECOMMENDATION — Ask for a copy of new catalog 215B on "Barco Flexible Ball Joints for Piping."

FOUNDED 1908 BARCO PRODUCTS BACKED BY EXPERIENCE

BARCO MANUFACTURING CO.
542N Hough Street, Barrington, Illinois
The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Rotary Joints
In Canada: The Holden Co., Ltd., Montreal

NEW BOOKS

Epoxy Resins Text

In "Epoxy Resins," the author clearly describes these versatile new materials as casting and potting compounds, adhesives, plasticizers, and explains both the "how" and "why" of epoxy uses.

The book gives the reasons behind each formulation to enable the reader to choose from the confusing and sometimes contradictory maze of available information. It also clarifies the puzzling array of trade names, and presents up-to-date formulations and manufacturing procedures.

(Skeist, Irving, *Epoxy Resins,* Reinhold Publishing Co., 430 Park Ave., New York 22, N. Y., 293 pages, $5.50. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, U.S.A.)

Uses For Polyurethanes

"Polyurethanes" is a new volume thoroughly portraying the remarkable uses and possibilities of these materials. It includes their many applications as foams, coatings, rubber (castings as well as tires), and adhesives. These latter three applications are becoming very important, and are fully covered in this new book. The publication also explains why America's yearly production capacity of polyurethanes has reached 70 million pounds, what this production is used for, and what the future holds in this field.

(Dombrow, Bernard A., *Polyurethanes,* Reinhold Publishing Co., 430 Park Ave., New York 22, N. Y., 176 pages, $4.50. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, U.S.A.)

New Chemistry Handbook

The "Handbook of Chemistry and Physics" contains complete basic information on physics, chemistry and mathematics, and is famous for its interpretation of factual data. The Handbook has continued to progress with the scope of the sciences ever since the first volume was published 45 years ago. Some of the important new information covers: electron physics table, thermodynamic properties of the elements, chelating agents, and ion exchange resins.

(*Handbook of Chemistry and Physics, 40th Edition,* Chemical Rubber Publishing Co., 2310 Superior Ave., Cleveland 14, Ohio, 3,300 pages, $12.00. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas.)

Petrochemicals Industry

"The Petroleum Chemicals Industry," by Dr. Richard F. Goldstein, repudiates the widely spread view that the saturated hydrocarbons present few problems, that their chemistry is simple and their behavior predictable. Nothing could be further from the truth for, as Dr. Goldstein's monograph clearly shows, many of their transformations are exceedingly difficult to understand, and the mechanisms of reactions in this group includes more unsolved mysteries than are found in most of the other series.

We have developed most of our ideas from experiments. But though it is not simple, petroleum chemistry is slowly getting on its theoretical feet, and that is true even regarding the phenomena of heterogeneous catalysis. Dr. Goldstein has given an excellent account of the facts that call for an explanation, although his main concern has been to describe the

For more data on advertised products, use Readers' Service Cards, last page.

NOW Ni-Resist ductile irons offer you new combinations of useful engineering properties

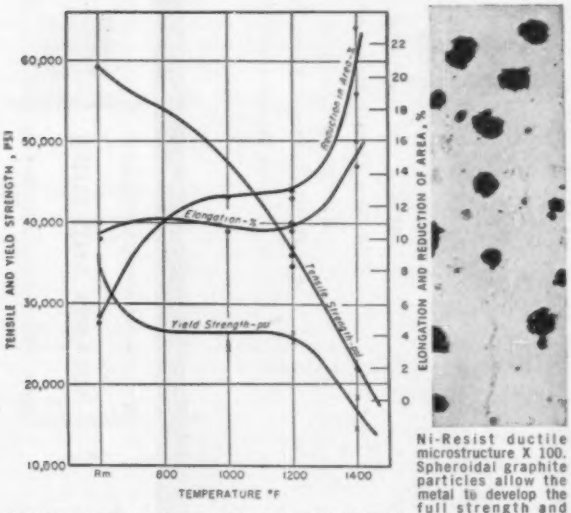
Ni-Resist* ductile irons are a new family of versatile high-alloy cast irons developed by Inco. Containing 18 to 36% Nickel, they provide the same high order of corrosion and heat resistance given by Ni-Resist flake graphite iron...plus high levels of strength and ductility.

There are several types of Ni-Resist ductile iron. Each one combines a useful array of engineering properties.

Strength Ni-Resist ductile irons provide tensile strengths of 55,000 to 80,000 psi, yield strengths of 30,000 to 44,000 psi. See graph of properties below.

Toughness Ni-Resist ductile irons give elongations of 4 to 40%, together with good impact resistance. The photomicrograph below shows why – spheroidal graphite particles allow formation of an austenitic matrix. This nickel alloy matrix develops full ductility and strength . . . keeps these properties at low temperatures.

Corrosion resistance Ni-Resist ductile irons safely handle hundreds of corrosives. Under most conditions – with acids, alkalies and salts – their performance is far superior to both cast iron and steel, helping you reduce maintenance costs.



High temperature tensile properties of Type D-2 Ni-Resist ductile iron.

Ni-Resist ductile microstructure X 100. Spheroidal graphite particles allow the metal to develop the full strength and toughness of the high alloy austenitic matrix.

High temperature properties Ni-Resist ductile irons form a tightly adhering scale at elevated temperatures, greatly reducing further oxidation. They resist heat effects up to 1400° F and higher, have excellent thermal shock resistance. From 1100° to 1300° F, Type D-2 has stress rupture properties equal to those of cast HF stainless steel.

Wear resistance Ni-Resist ductile irons have a work hardening austenitic matrix. Graphite particles provide dry lubrication. Both properties work together to resist wear and galling over a wide temperature range.

Erosion resistance Ni-Resist ductile irons work well in wet steam, brine or salt slurries, and high velocity liquids. Their high strength and resistance to cavitation-erosion mean long service life for pump parts.

Controlled expansion Ni-Resist ductile irons have thermal expansivities from about 2.5 up to 10.4 millionths per degree F. You can match them with steels, cast irons, Nickel, Monel* alloy...with aluminum, copper, bronze and stainless steel.

Non-Magnetic properties Ni-Resist ductile irons, Types D-2 and D-2C, are non-magnetic and therefore useful where excessive heat and power losses must be avoided.

Machinability Ni-Resist ductile irons machine as well as common pressure-type gray iron, thanks to the presence of graphite in their structure.

Fluidity in casting Ni-Resist ductile irons have good flowing qualities and permit the making of intricate designs.

These are only the highlights. You can get *all* the facts on this versatile new family of metals by asking us for "Engineering Properties of Ni-Resist Ductile Irons." This 28-page booklet details engineering properties and commercial applications with numerous photos, tables, and graphs . . . gives you the information you need to decide how Ni-Resist ductile irons can help you. You'll also get "Buyers' Guide for Ni-Resist and Ni-Resist Ductile Iron Castings", listing foundries authorized to produce them.

*Registered trademark

THE INTERNATIONAL NICKEL COMPANY, INC.

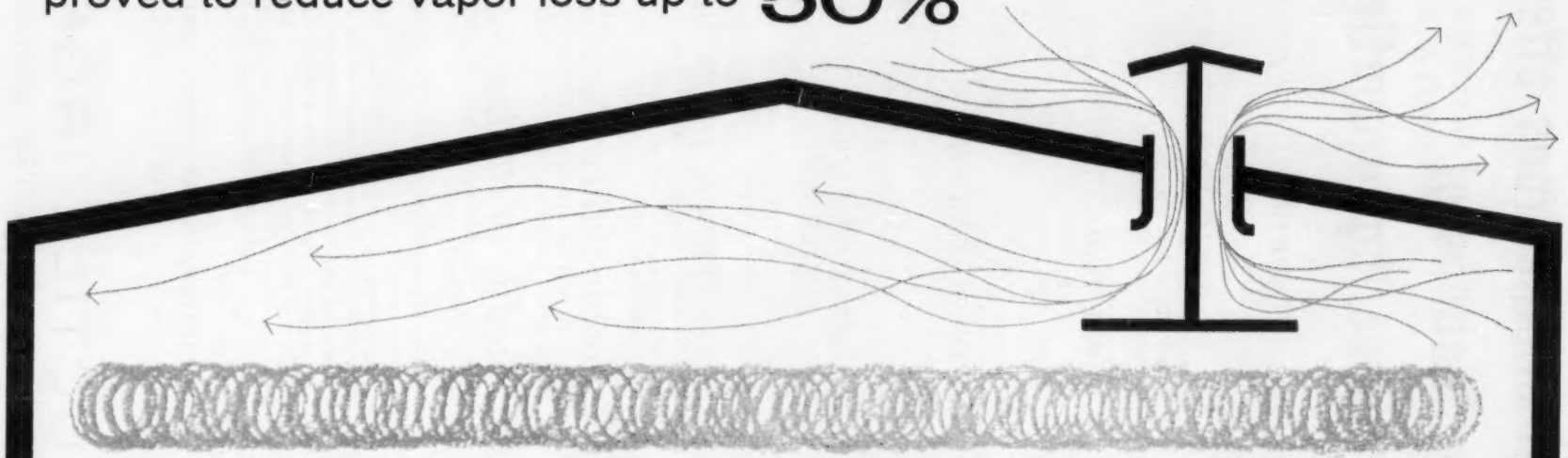
67 Wall Street INCO New York 5, N.Y.

NI-RESIST DUCTILE IRONS

NICKEL ALLOYED IRONS PERFORM BETTER LONGER

S&J AIR BAFFLE*

proved to reduce vapor loss up to 50%



Downward velocity of air jetting into a tank through the breather vent causes currents which induce rapid product evaporation. S & J Air Baffle is a device which deflects incoming air into stratified layers above heavier, gas-rich air. The result is materially reduced surface boiling, with vapor losses cut from 25 to 50%. Unique Air Baffle design permits simple installation through the vent nozzle on tanks in service. Call or write for complete details and prices.

*Patented

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scope of the industry; what has been done and how it was done.

(Goldstein, R. F., *The Petroleum Chemicals Industry*, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 458 pages, $16.50. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, U.S.A.)

Develop Executive Skills

"Developing Executive Skills" is a comprehensive handbook for companies concerned with executive performance. In many companies, management development is accepted as an important method of making the most of existing manpower resources and insuring an adequate reserve of key personnel for future expansion. To be completely successful in management development, a thorough knowledge of modern principles and techniques is required.

"Developing Executive Skills" furnishes this information. Reporting on current practice followed by leading American companies, this publication features 14 entirely new case studies of actual company programs for management development. Practical approaches for appraising, training, and improving managerial talent are discussed.

It is the one handbook for the alert executive who must cope with the complex responsibilities of today's management.

(Merrill, H. F., and Marting, Elizabeth (Editors), *Developing Executive Skills*, American Management Association, Inc., 1515 Broadway, Times Square, New York 36, N. Y., 425 pages, $9.00.)

Gaseous Fuel Standards

ASTM "Standards on Gaseous Fuels D-3" replaces the previous edition issued in 1954. It contains four methods for sampling and measurement and nine methods of testing and analysis. Of these, seven are new, revised, or have had their status changed since the last edition was published. Natural gas, manufactured gas, and liquefied petroleum gases are the materials for which these standards were specifically written.

(ASTM, *Standards on Gaseous Fuels D-3*, American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., 204 pages, $3.00.)

Gas Facts and Data

The American Gas Association now has available for distribution copies of its 1958 editions of "Gas Facts" and the "Gas Data Book." The former publication, its annual statistical year book, presents comprehensive information on all phases of gas industry operations during 1957 and earlier years. Some of the subjects covered include energy reserves, natural gas production, natural gas exploratory and developmental drilling, manufactured gas production, the transmission and distribution of gas, the development of underground storage facilities, customers, sales and revenues of the industry, gas appliance shipments, sales of gas to large industrial users, new security issues of the industry, financial results of different categories of gas companies, industry income statements, balance sheets and operating expenses, past and anticipated construction expenditures, employees and payroll expenditures, the cost of gas and other competitive commodities, and a review of the Canadian gas industry.

The "Gas Data Book" is a pocket-sized

THE MARK OF QUALITY

BARBER COLMAN

Wheelco Instruments

Precision Instrumentation Aids Petroleum Industry Product Research

Here's a completely instrumented unit that plays an important part in major oil company research aimed at developing new products and improving existing ones. Known as a "Sarnia Fractionator," it is a development of H. S. Martin Company, Evanston, Illinois.

Upper recorder, with a 12 mv range, records and controls vacuum from atmospheric to .01 mm pressure while the lower recorder is a multipoint unit that reads and records various zone temperatures in the fractionating equipment. The two controllers at the upper left of panel control temperature of charge and product stream of the equipment.

Ranges, control forms, and accuracies of all instrumentation in this installation are ideally matched to equipment needs to provide outstanding performance at realistic cost. The same qualities of process instrumentation experience and clear-headed practicality can be applied to your next job — just get in touch with your nearby Wheelco field engineer for details.

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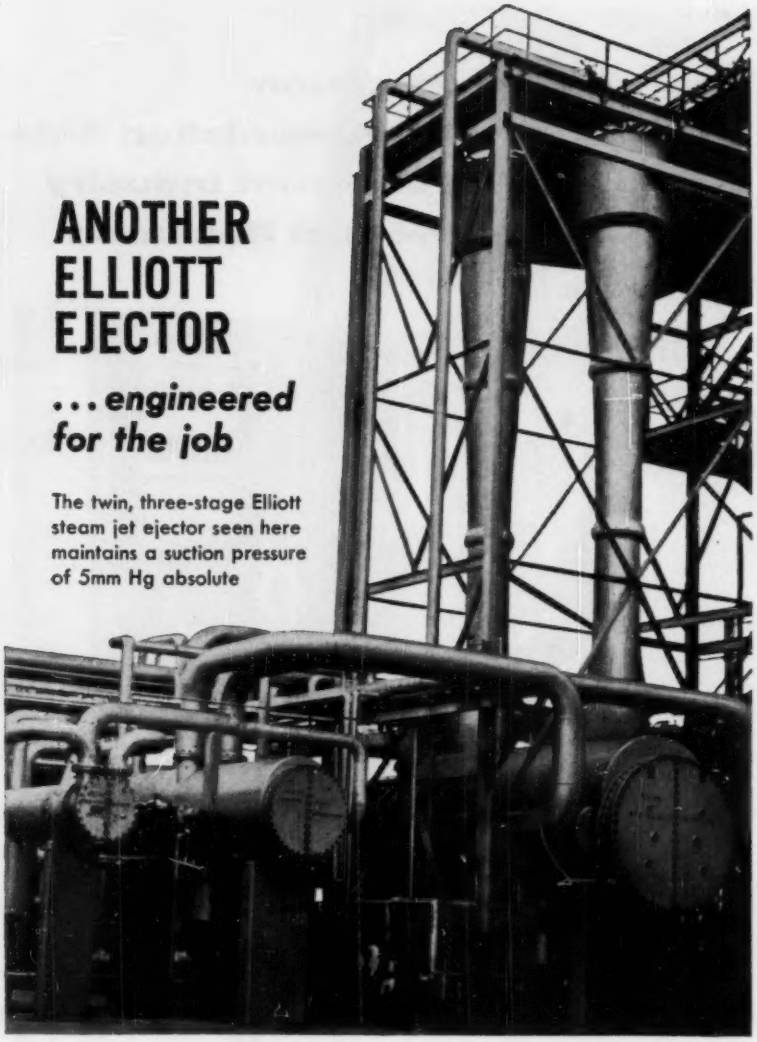
Dept. L, 1597 Rock Street, Rockford, Illinois, U.S.A.

BARBER-COLMAN of CANADA, Ltd., Dept. K, Toronto



ANOTHER ELLIOTT EJECTOR

... engineered for the job

The twin, three-stage Elliott steam jet ejector seen here maintains a suction pressure of 5mm Hg absolute

designed to serve world's largest crude oil unit

This unique, giant-sized ejector is the largest vacuum installation ever built. The design problem here was to engineer a unit which would efficiently and economically maintain the specific suction pressure required by the application. To accomplish this, Elliott engineers designed a twin-type ejector with two vertical first-stages which are 40 ft long, have 60-inch diameter inlets, and discharge to a 20,000-sq ft intercondenser. The two 20-inch second-stage ejectors discharge to a 6000-sq ft intercondenser and the third-stage ejectors discharge to a 3000-sq ft aftercondenser.

write us for descriptive bulletins

Available literature on single-stage, multistage and corrosion-resisting types illustrate Elliott's versatility in ejector design and construction for all sorts of chemical and industrial process applications. Contact your nearby Elliott District Office or write Elliott Company, Jeannette, Pa.

ELLIOTT Company

Send for complete details today

GB-2

summary of the most salient statistics regarding the operations of the industry for convenient reference.

(AGA, *Gas Facts*, $3.00 per copy for first five, $1.50 for all additional, *Gas Data Book*, $.50 per copy, $.25 per copy for all additional, American Gas Association, 420 Lexington Ave., New York 17, N. Y.)

Plant Operations Manual

Natural Gasoline Association of America's "Plant Operations Test Manual" is a collection of more than 80 test methods widely used in the control of gas processing plants. It is designed as a convenient, one-stop library of test methods.

The publication was compiled by NGAA's Plant Control committee. The committee will keep the test methods under constant review, and book holders will automatically receive future revisions and additions as required by changes in methods or plant needs.

Tests included in the manual are reproduced by special arrangement with originating organizations, such as American Society for Testing Materials, The Girdler Corp., The Fluor Corp., Betz Laboratories, and others.

Designed for plant laboratory use, the test manual is durably bound in waterproof, 8½ x 11-inch loose leaf binder, and is completely indexed for ease of use.

(NGAA Plant Control committee, *Plant Operations Test Manual*, Natural Gasoline Association of America, 421 Kennedy Bldg., Tulsa 3, Okla., $12.00.)

Pressure Vessel Guide

Availability of RP 510, "API Recommended Practice for Inspection, Repair, and Rating of Unfired Pressure Vessels in Service in Petroleum Refineries," has been announced by the American Petroleum Institute. This is the First Edition, 1958.

This recommended practice covers the inspection, repair, evaluation for continued use, and the methods for computing the maximum allowable working pressure of unfired pressure vessels constructed in accordance with any of the several editions of the former API-ASME Code for Unfired Pressure Vessels, the several editions of Section VIII, of the ASME Boiler and Pressure Vessel Code, or codes based on either of these.

(API, *RP 550, API Recommended Practice for Inspection, Repair, and Rating of Unfired Pressure Vessels in Service in Petroleum Refineries*, Publications department, American Petroleum Institute, 50 W. 50th St., New York 20, N. Y., $1.00)

Fire Safety Standards

The six-volume 1958 edition of fire safety standards is a compilation of the 170 standards developed by NFPA. The six new volumes, with a total of 4,800 pages, by title and content are:

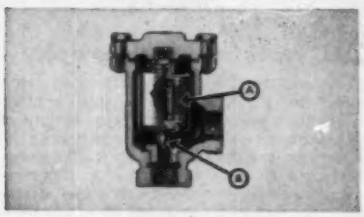
- Volume I—Flammable Liquids and Gases (35 standards, 896 pages).
- Volume II—Combustible Solids, Dusts, Chemicals and Explosives 35 standards, 656 pages).
- Volume III—Building Construction and Equipment (31 standards plus an informative discussion of building codes and references to model codes, 744 pages).
- Volume IV—Extinguishing Equipment (33 standards, 1136 pages).
- Volume V—Electrical (The National Electrical Code, 1956 edition, including

Full-range steam traps cut high cost of steam pressure variations

By John W. Ritter, Test Engineer
SARCO Company, Inc.

While boiler room economics dictate that boiler pressures remain constant, the equally sound economics of batch processing may decree that pressures at the equipment vary with the requirement of the process. The attempt to choose a steam trap that is all things to all conditions may result in installing traps that operate inefficiently at either extreme of their pressure range or that require adjustment every time the operations sheet calls for another pressure-temperature setting. Orifice traps represent a somewhat more rational approach to the problem, but often at the price of a continuous discharge of steam, particularly at the low pressures of start-up and shut down. Compromise, adjustment, and steam waste all spell inefficiency in the utilization of steam.

Production-Planned steam trapping, on the other hand, improves efficiency by the use of properly designed and installed thermostatic steam traps. Such traps employ the expansion and contraction of a thermostatic element to operate the discharge valve.



In Sarco Thermostatic Steam Trap, element (A) expands at steam temperature to close valve (B), contracts to permit discharge of condensate.

In the Sarco "Balanced Pressure" Thermostatic Steam Trap a volatile fluid is sealed inside a metal bellows that opens or closes the valve as it contracts or expands with condensate temperature. Near steam temperature, evaporation of the fluid creates an internal pressure greater than steam pressure in the trap body, and the expanding bellows seats the valve. When the condensate cools, the element contracts and opens the valve.

It is evident that at steam temperature pressure inside the element is higher than steam pressure, no matter how the latter may vary. Thus, the trap compensates automatically for variations in pressure.

5810B

Sarco "Balanced Pressure" Thermostatic Steam Traps cut trap maintenance costs and simplify parts inventory. Why? Because the same bellows, head and seat handle steam pressures up to 300 psi – without any need of adjustment for variations in load or pressure.

Other advantages: unmatched capacity/cost ratio (1" size discharges 9,650 lbs/hr. at 10°F below steam temperature, 125 psi). This trap can't air-bind and, when installed with free discharge, can't freeze.

Long life and reliable performance are assured by an exclusive Sarco process for fabricating the one moving part – the thermostat – and by steam-testing of every single trap at maximum rated pressure.

Write for "Literature Kit 1A" today. And remember, Sarco can give you impartial advice on *Production-Planned* steam trapping because . . .

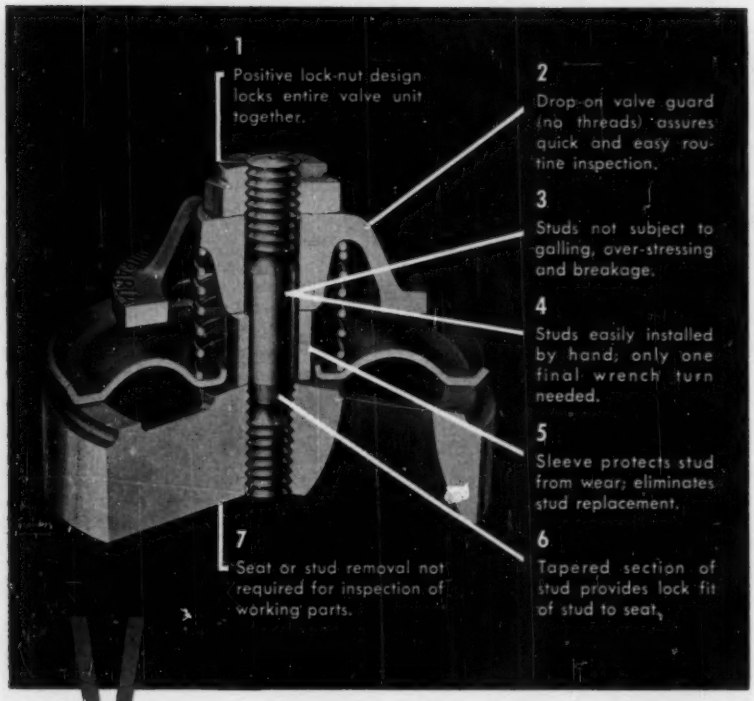
SARCO
COMPANY, INC.
635 Madison Ave., New York 22, N. Y.

Only Sarco makes all 5 types:
Thermostatic • Liquid Expansion • Float Thermostatic
Thermo-Dynamic • Bucket

STEAM TRAPS • TEMPERATURE CONTROLLERS • STRAINERS • HEATING SPECIALTIES

For more data on advertised products, use Readers' Service Cards, last page.

Now...DURABLA Pump Valves offer 7 new points of superiority!


1
Positive lock-nut design locks entire valve unit together.
2
Drop-on valve guard (no threads) assures quick and easy routine inspection.
3
Studs not subject to galling, over-stressing and breakage.
4
Studs easily installed by hand; only one final wrench turn needed.
5
Sleeve protects stud from wear; eliminates stud replacement.
6
Tapered section of stud provides lock fit of stud to seat.
7
Seat or stud removal not required for inspection of working parts.

New V-design assures even greater dependability

You want *maximum valve dependability* for your reciprocating pumps . . . and DURABLA gives you just that in the new V-7 unit.

Incorporating seven points of superiority, the new valve features a tapered or V-shaped stud which screws down tight to the seat. This exclusive design anchors the stud, eliminating any possibility of galling, over-stressing or breakage. What's more, the new self-locking nut and drop-on guard assure quick and easy inspection of working parts—without stud or seat removal.

Remember: In the DURABLA Valve, only "point contact" is made by the valve member on the stud sleeve, so it can't bind or hang-up. The open-type guard assures free flow of liquid, prevents clogging.

These stainless-steel valves operate freely under temperature extremes, with corrosives, and in any position. Made in 15 sizes to fit any reciprocating pump, old or new.

Send for *NEW* 8-page booklet PR-128.

Keep your pumps fit with the valves that fit all pumps.

DURABLA®

DM-26

DURABLA MANUFACTURING COMPANY

114 Liberty Street • New York 6, New York

BOOKS *continued*

interpretations and interim amendments to July 30, 1958, plus six other NFPA electrical standards and a digest of the electrical provisions of 76 other NFPA standards, 720 pages).

• Volume VI—Transportation and Misc. (28 standards on air, marine, bus and truck transportation and salvage, plus a comprehensive review of applicable government regulations, 672 pages).

The codes, in keeping with the traditional objectives of the NFPA, are offered as a suggested basis for safety to life and property from fire without causing undue inconvenience and expense.

(NFPA, *The National Fire Codes*, Publications Department, National Fire Protection Association, 60 Batterymarch St., Boston 10, Mass., $7.00 per volume.)

Operations Research Text

Is operations research a scientific and analytical tool that solves business problems? What are its potentialities and limitations? How effective is it as a tool for improving management decisions?

"Operations Research Reconsidered" provides timely answers to these questions, based on actual company experience. The report deals with material presented on November 25-27, 1957, at a special conference sponsored by the Finance division of the American Management Association. These papers demonstrate how OR methods have reduced costs and increased profits in budgeting and economic planning, inventory control and distribution, plant location, and trend forecasting.

(AMA Finance Division, *Operations Research Reconsidered*, American Management Association, Inc., 1515 Broadway, Times Square, New York 36, N. Y., 100 pages, $3.00.)

AEC Isotopes Bibliography

A bibliography of open-literature references to U. S. research into reactor-produced radioactivity and applications of radioisotopes in industry has just been released by the Atomic Energy Commission. Designed to serve as a guide to the technical aspects of isotope research and utilization, the bibliography contains nearly 6000 references which are categorized into 30 fields of work with radioactive and stable isotopes. Reference is made to materials appearing in scientific, technical, and professional journals during the three years ending December, 1957. An author index and a key to journal abbreviations are included in the bibliography.

(OTS, *Isotopes: A Bibliography of U. S. Research and Application, 1955-57 (TID-3076)*, Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C., 267 pages, $2.25.)

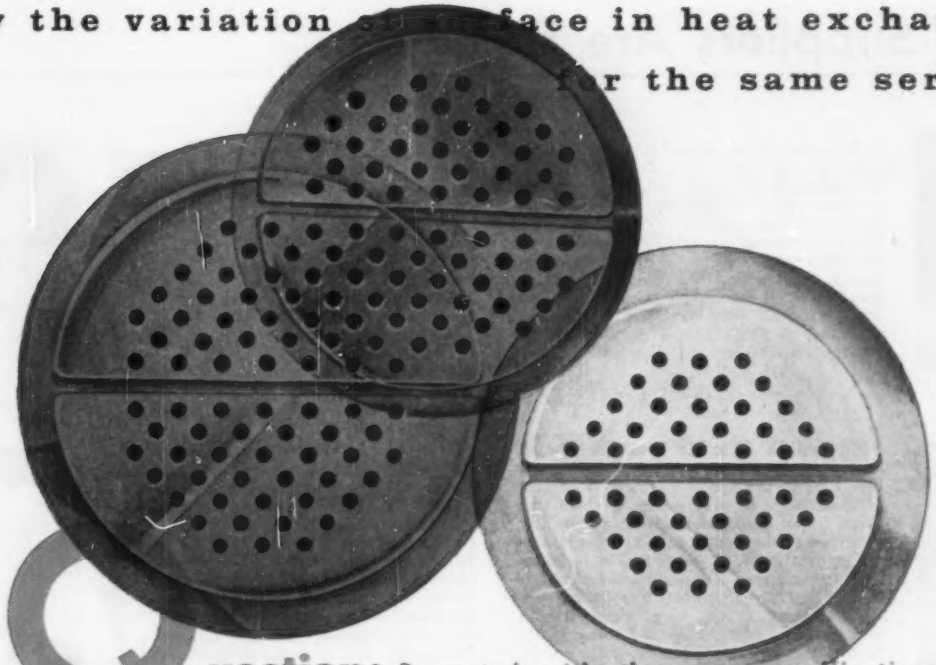
Canadian Oil Progress

"Dynamic Decade" tells the amazing story of oil discovery at Leduc, Alberta, in 1947. It shows the far-reaching consequences of this and other discoveries for Alberta and Canada. The book describes how the oil companies, large and small, have all had their share in Canada's oil development, including exploration and development, and the multiplicity and variety of labor involved—from the original financing and employment of geological and drilling crews to the work of engineers, architects, and construction men.

(Hanson, E. J., *Dynamic Decade*, McClelland & Stewart, Ltd., 25 Hollinger Road, Toronto 16, Canada, 314 pages, $6.00.)

For more data on advertised products, use Readers' Service Cards, last page.

Why the variation [illegible]face in heat exchangers [illegible]r the same service?



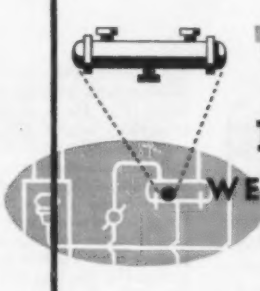
Question: Presented with the same specifications, what justification is there to the variation of surfaces offered by a number of reputable suppliers of heat exchanger equipment, for a given service?

Answer: Since heat transfer calculation to date is not an exact science, the data on which design curves are based may vary over a wide range, and EXPERIENCE is often the deciding factor, SO THAT . . . .

. . . . Western's years of experience in heat exchanger design, with both the small independent refiners as well as with the giants of the industry, are a great asset in helping you select the equipment you need for your *specific problem.*

Personal attention to detail and knowledge of customer preferences are integral in each Western-customer relationship. Utilizing the most modern methods and machinery in rating and fabrication results in achieving the highest heat transfer efficiency at realistic prices.

Western specifies the surface to fit your specific service — no more and no less.



WESTERN

HEAT EXCHANGERS

WESTERN SUPPLY COMPANY

P.O. Box 1888 – Tulsa, Oklahoma

For more data on advertised products, use Readers' Service Cards, last page.

What Suppliers Are Doing . . .

Cummings

Raymond W. Cummings has been elected treasurer of Crouse-Hinds Co., succeeding J. R. Tuttle, who will continue as chairman of the board. Cummings has been with the company since June 1956. He was elected secretary in April 1958, and serves in a dual capacity. Formerly he was a partner in the public accounting firm of Gilfoil, McNeal & Cummings, and an accountant with Wickwire Brothers in Cortland, N. Y. He is a member of the Controllers Institute of America.

V. R. Hershberger has been appointed sales representative for C. Lee Cook Co., in Eastern Ohio. He has been in sales engineering for seven years, and most of this experience has been in mechanical packings. Prior to entering sales, Hershberger served as a mechanical engineer for Indianapolis Power and Light Co., Indianapolis, Ind., for 14 years. He studied engineering at Purdue University. Hershberger will represent the complete line of Cook products.

Hershberger

Fleischer

Edward P. Fleischer has been named assistant to the president, Consolidated Electrodynamics Corp. Formerly manager of systems and procedures, he will be given broad responsibilities in supporting activities of the president's office. Prior to his appointment as manager of systems and procedures, Fleischer was staff assistant to the president for two years, and staff assistant to the vice president and director of engineering for two years. Earlier, he was with Beckwith Elevators, Ltd., and Standard Oil Co. of Calif.

Louis A. McGowan, chief engineer of Rockwell Manufacturing Co.'s DuBois, Pa., gas meter plant has been named assistant chief engineer for the firm's Barberton division. He joined Rockwell in 1947 as a project engineer at Pittsburgh. Before joining DuBois in 1950 he was an engineer for two years at the company's Norwalk, Ohio, Regulator division. A native of Pittsburgh, he attended Carnegie Institute of Technology and the University of Pittsburgh. He is a member of ASTM, ASME, and AGA.

McGowan

Johnson

William F. Johnson has been named to direct a new department responsible for product marketing direction, planning, and sales-support activities for the DataTape, Transducer, Central Manufacturing, and Analytical & Control Instrument divisions, Consolidated Electrodynamics Corp. The department includes separate marketing sections for each of the four product divisions. Johnson joined CEC in 1947 as a design engineer. He became manager of application service in 1951, manager of sales operations in 1953, and director of sales in 1956.

Sven T. G. Swanberg has been assigned to Cooper-Bessemer Corp.'s New York field office. He will assist in engineering and sales. A graduate in mechanical engineering from the University of Stockholm and from General Motors Institute of Technology, Swanberg holds a mechanical engineering degree. Since joining the company, he has been with the New York office of the Cooper-Bessemer International Corp. as sales engineer for four years. He was also branch manager, Cooper-Bessemer International, Havana.

Swanberg

Fontana

Louis F. Fontana has been appointed a vice president and general sales manager of Irving Subway Grating Co., Inc. He joined the company in 1930, was made contract manager in 1946 and became sales manager in 1948. Fontana was president of the National Association of Architectural Metal Manufacturers for two one-year terms, starting in 1956. He is now a member of the Board of Directors of that organization. He has a B.B.A. degree from the College of the City of New York.

J. T. Teed has been appointed, by Brown Instruments division, Minneapolis-Honeywell Regulator Co., market manager for petroleum industry instrumentation. He joined Honeywell in 1950 as sales engineer in the Tulsa district office. He later served as industrial sales manager in Tulsa and as Eastern sales supervisor, systems engineering, prior to his present assignment. Teed was graduated from Texas A. & M. College in 1950 in electrical engineering. He is a member of ASM, ISA, and Tulsa Pipeliners Club.

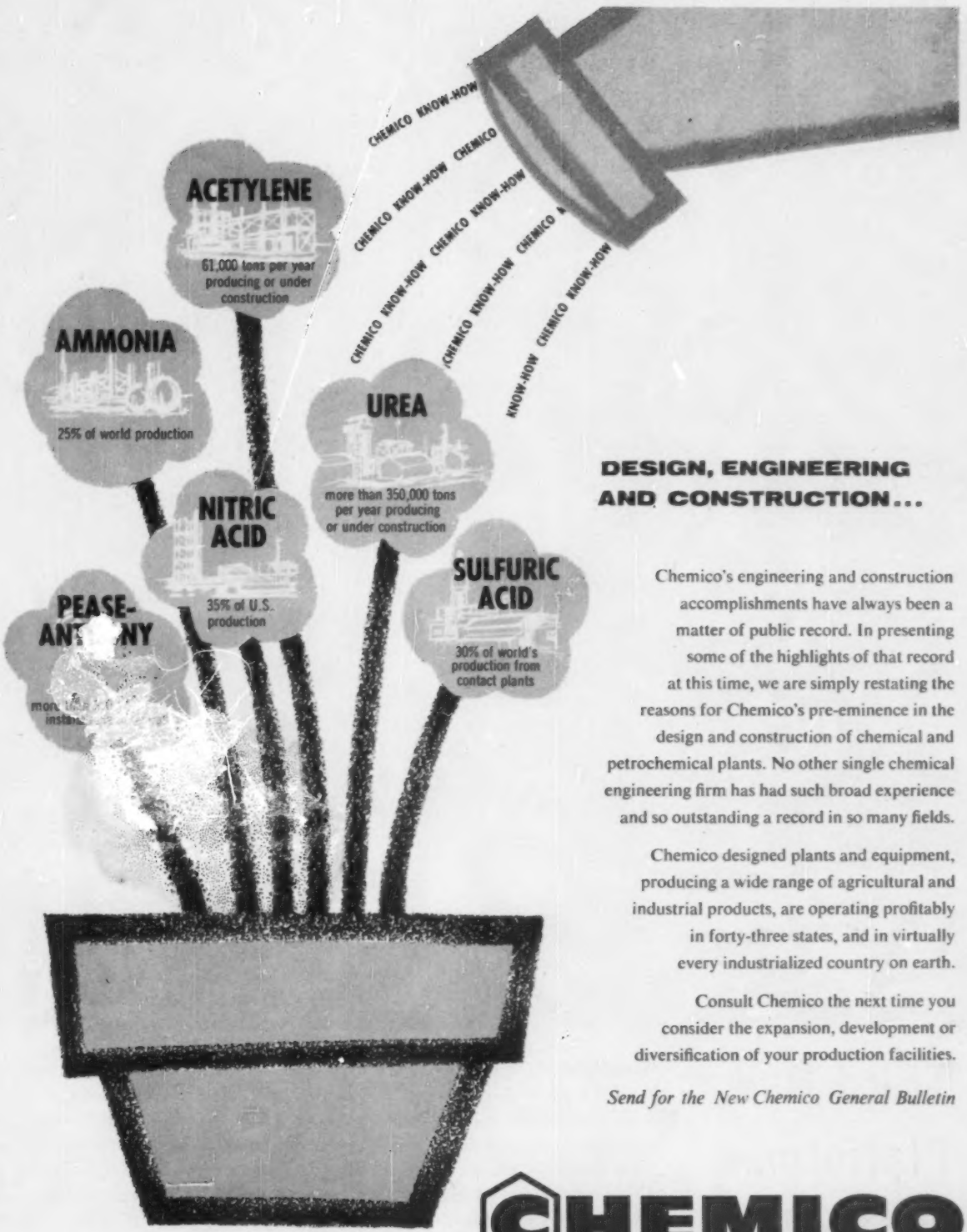
Teed

Woodard

P. H. Woodard of Bailey Meter Co., has been appointed resident engineer in Omaha, Nebr., subdivision of the Kansas City district. He joined the company in 1951 as a cadet engineer, and has been on the Kansas City staff since June 1953. He served in the army from 1953-55, returning to the Kansas City district after his discharge. Woodard graduated from the University of Kansas in 1951, with a B.S. degree in mechanical engineering.

James A. Dayton has been elected vice president-manufacturing of American Meter Co. He is in charge of the Manufacturing, Methods & Tooling, Engineering and Industrial Relations departments and for manufacturing operations producing measurement and control equipment in company plants throughout the U. S. Prior to joining American Meter, Dayton was director, executive vice president and secretary of Turner & Seymour Manufacturing Co. He was formerly with American Bosch Co., Lux Clock Co., Skinner Motors, Inc., and Dayton Manufacturing Co.

Dayton



DESIGN, ENGINEERING AND CONSTRUCTION...

Chemico's engineering and construction accomplishments have always been a matter of public record. In presenting some of the highlights of that record at this time, we are simply restating the reasons for Chemico's pre-eminence in the design and construction of chemical and petrochemical plants. No other single chemical engineering firm has had such broad experience and so outstanding a record in so many fields.

Chemico designed plants and equipment, producing a wide range of agricultural and industrial products, are operating profitably in forty-three states, and in virtually every industrialized country on earth.

Consult Chemico the next time you consider the expansion, development or diversification of your production facilities.

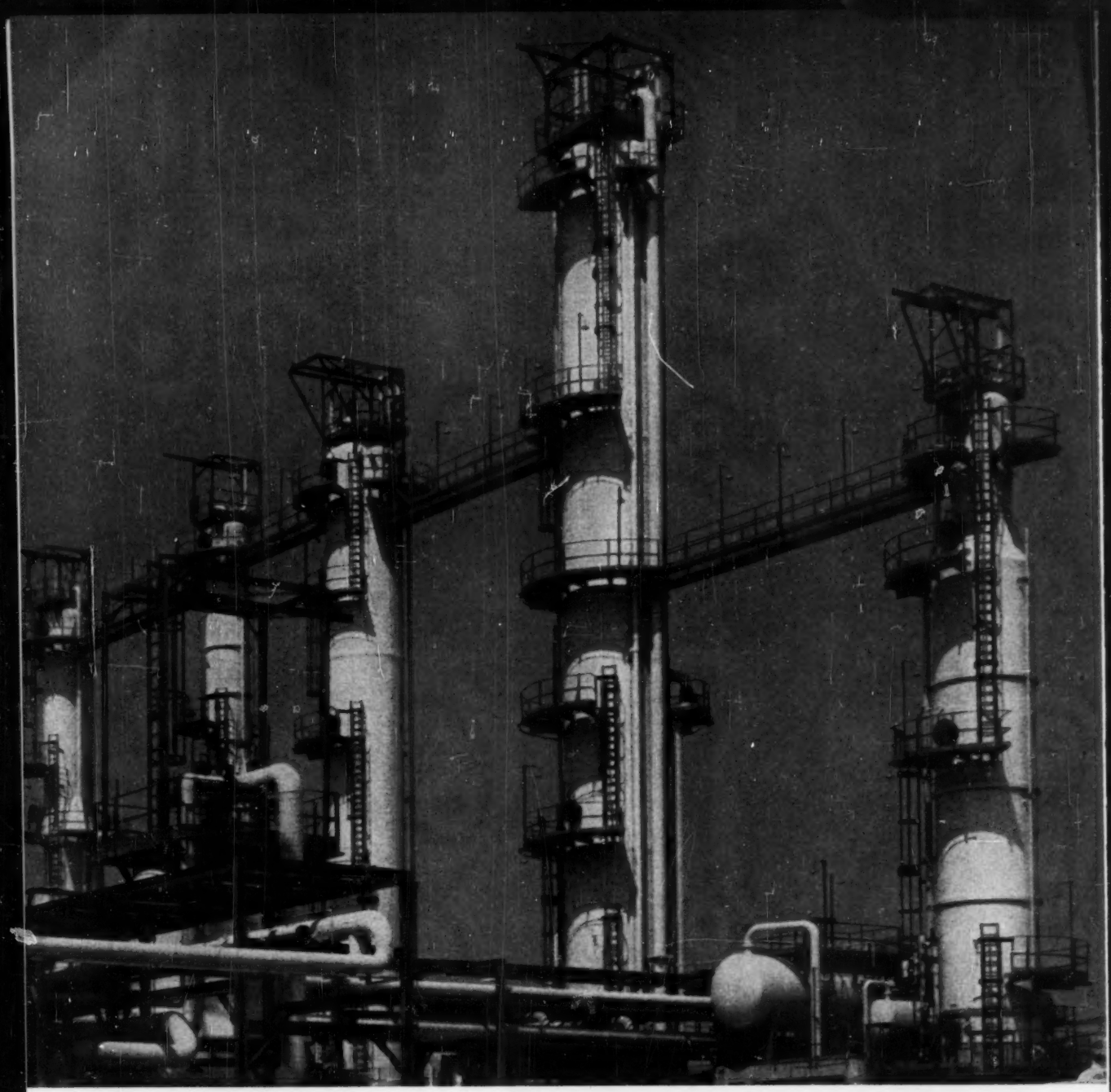
Send for the New Chemico General Bulletin

CHEMICO

CHEMICAL CONSTRUCTION CORPORATION
525 West 43rd Street, New York 36, New York

CHICAGO • DALLAS • HOUSTON • PORTLAND, ORE. • TORONTO • LONDON • PARIS • JOHANNESBURG • TOKYO

For more data on advertised products, use Readers' Service Cards, last page.



Third New Platformer for Gulf...

COLUMNS BY

GRAVER®

The third of three new 26,000 b/d Platforming® units to be installed by the Gulf Oil Corporation is now on stream at Gulf's Port Arthur refinery. Built under license from the Universal Oil Products Company, this latest installation will substantially increase the high octane potential at the refinery.

The five large columns above and two separator units were shop-fabricated at Graver's East Chicago plant and erected by Procon Incorporated, the general contractor. Eighteen columns for the other two Platforming unit installations at Gulf's Philadelphia refinery were also shop-fabricated at Graver's East Chicago plant.

Large or small processing equipment for petroleum, petrochemical, chemical and nuclear energy installations are produced with dispatch and skill by Graver artisans. Graver's century of experience means quality construction.

GRAVER TANK & MFG. CO., INC. EAST CHICAGO, IND.

PLANTS AND OFFICES ACROSS AMERICA

Suppliers . . .

H. K. PORTER CO., Inc.'s Refractories division, in addition to enlarging facilities at its Ottawa, Ill., works, will soon operate a warehouse in the Chicago-Gary area.

CLARK BROS. CO. has formed a Nuclear Products department. **John K. Hubbard**, former manager, Product Engineering, has been appointed manager, and will be responsible for the engineering and marketing of products developed by the department.

U. S. STEEL CORP.'s Wilson-Snyder works, Oil Well Supply division is placing its own district sales engineers in New York, Chicago, Tulsa, Houston, Los Angeles and at its Braddock, Pa., headquarters.

THE FIRST NATIONAL CITY BANK OF NEW YORK has assigned **William I. Spencer**, vice president, general supervision of the bank's Petroleum department, succeeding **J. Ed. Warren**, formerly senior vice president, who recently joined Cities Service Co. as chairman of the executive committee and director. Spencer has been instrumental in the development of special banking services for clients in the petroleum industry. As administrative head of the department he directs the activities of a group of petroleum engineers, geologists, and lending officers, who render financial counsel to the oil industry. A native of Grand Junction, Colo., he attended Colorado College and Columbia University.

Spencer

BECKMAN INSTRUMENTS, INC.'s Helipot division has appointed **Stanley Schneider** manager of engineering. He will direct the design, development and modification of various equipment. Schneider joined Beckman in 1953 as a research engineer. He holds a B.S. degree in physics from Columbia University.

U. S. INDUSTRIES, INC. has appointed **Philip A. Roth** to the board of directors. He is chairman of the executive committee, executive vice president and a director of General Industrial Enterprises, Inc. He is chairman of the executive committee, vice president and a director of Baldwin Securities Corp. Roth is also a director of the Trade Bank and Trust Co., a director and vice chairman of the Budget and Finance committee of Loew's Inc., a trustee and vice chairman of the board of trustees, Title Guarantee and Trust Co., and a director of S. Stroock & Co., Inc.

Roth

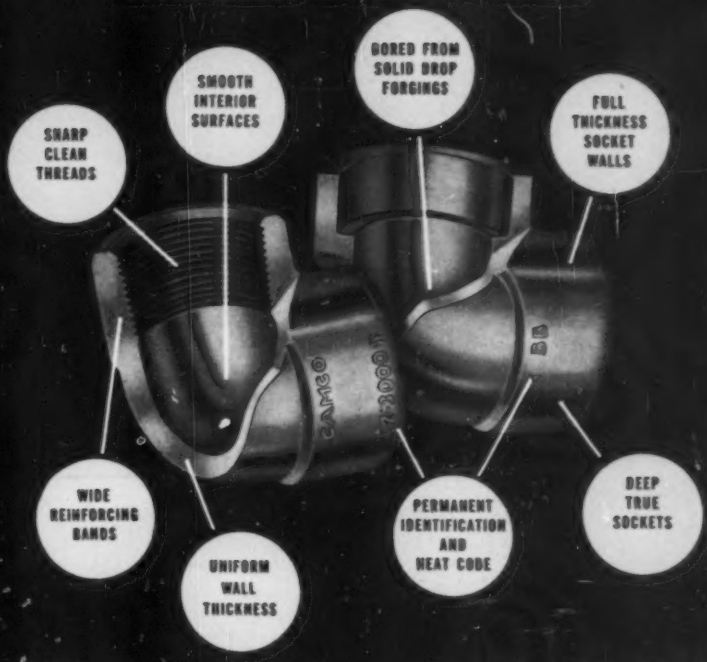
U. S. STEEL CORP.'s Oil Well Supply division has transferred **Wallace L. Reed** district engineer, from Houston to Jackson, Miss. He joined the division in 1948. He was appointed assistant district engi-

SPECIFY

CAMCO

THE Quality LINE IN FITTINGS

2000 Lb., 3000 Lb. and 6000 Lb.
SCREWED and SOCKET WELD
STAINLESS STEEL FITTINGS



Special non-standard fittings furnished to order . . . One source for all your stainless fitting requirements.

Also available—150 lb. screwed fittings and all schedules of buttweld fittings.

CAMCO FITTINGS, INC., 301 State Street
North Haven, Conn.

☐ Catalog Extra Heavy 657. M&R
☐ Catalogs covering complete line. CE
☐ Furnish address of area distributor. PR

NAME_____
COMPANY_____
ADDRESS_____
CITY_____ ST._____

THE Quality LINE IN FITTINGS

CAMCO FITTINGS, INC.

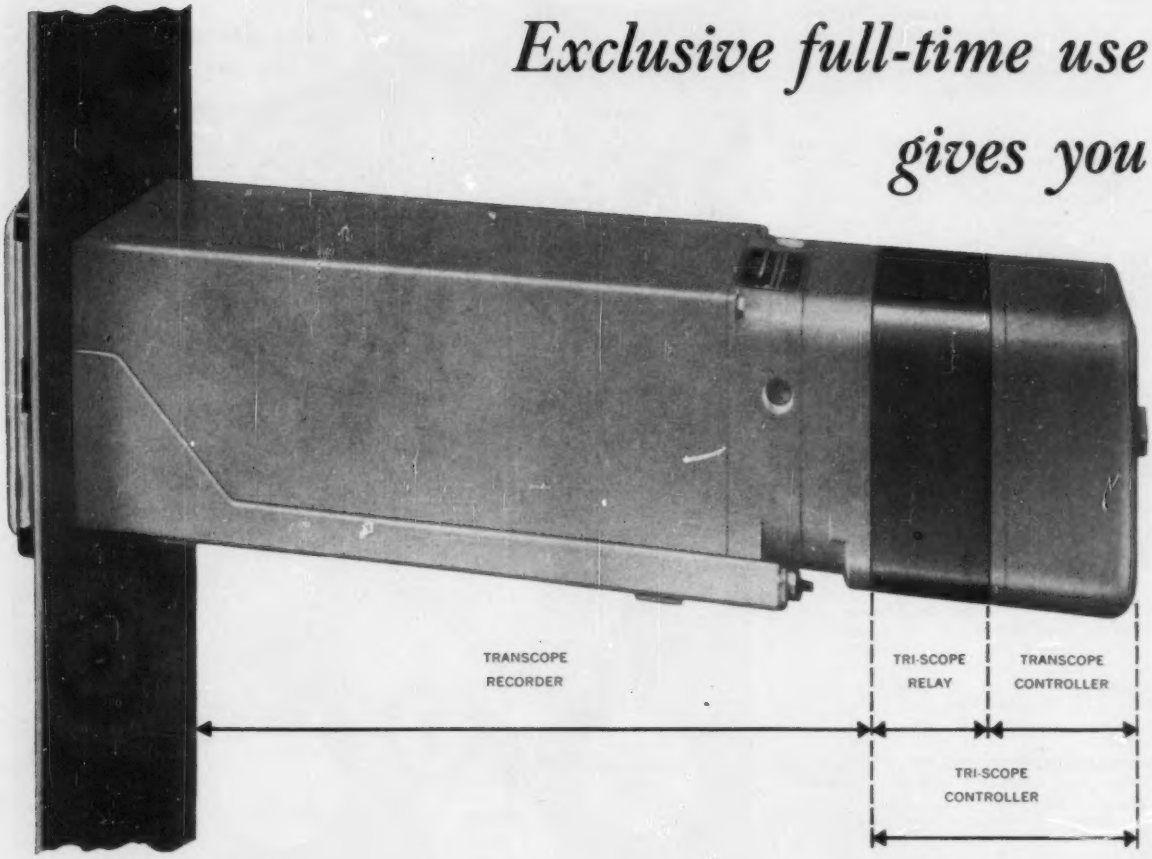
No. Haven, Conn.

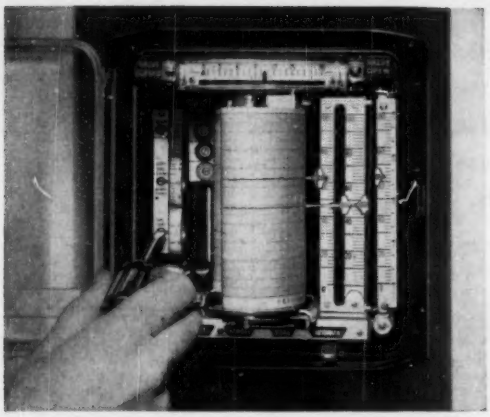
WEST COAST AGENT AND WAREHOUSE
J. J. GATELEY CO.
8283 Baldwin Street
Oakland 21, California

For more data on advertised products, use Readers' Service Cards, last page.

NEW TAYLOR

Exclusive full-time use gives you





DESIGN FEATURES

- *Plug-in construction.*
- *Response adjustments made from front or back of panel.*
- *Mounts neatly between TRANSCOPE Recorder manifold and TRANSCOPE Controller.*
- *Can be added whenever process changes require it.*
- *Either field or panel mounting available.*
- *Uses standard TRANSCOPE parts.*

*Trade-Mark

90J SERIES
TRANSCOPE RECORDER

Taylor Instruments

TRI-SCOPE* CONTROLLER

of derivative-ahead-of-reset response†
these three important features

1 – Start up without overpeaking

2 – Recovery from large load changes without overpeaking

3 – Superior control following normal load changes

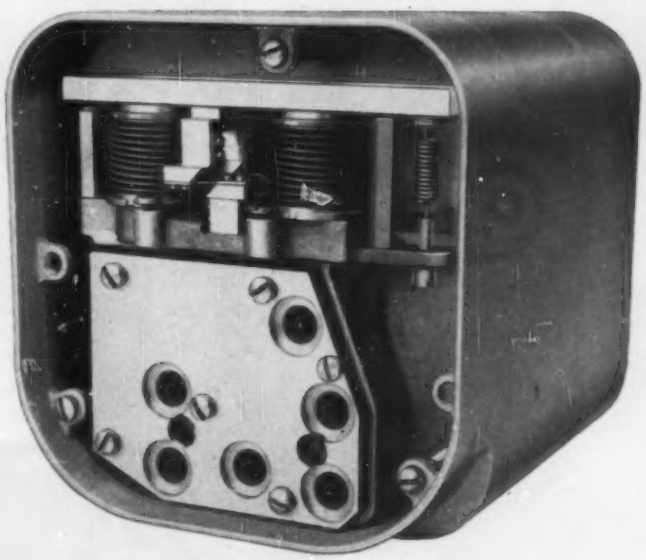
†Pioneered by Taylor in the TRI-ACT Controller*

HERE is the perfect solution to your problems of overpeaking on start-up and large load changes—inherent weaknesses of proportional-plus-reset controllers. It is equally effective *at all times* whether variable is approaching control point from above or below—on start-up, or following major process disturbances or changes in set point.

The TRI-SCOPE Controller consists of a proportional-plus-PRE-ACT*-response relay, called the TRI-SCOPE relay, and a proportional-plus-reset TRANSCOPE* Controller. This combination provides controller characteristics similar to that of the TRI-ACT Controller, making possible the three major benefits listed above.

This unique new controller has been time-proven on one of the toughest possible reactor applications. For full information see your Taylor Field Engineer, or write for Bulletin No. 98332. Taylor Instrument Companies, Rochester, N. Y., or Toronto, Ont.

For Vision . . . Ingenuity . . . Dependability in solving your process control problems.



NEW 414RF TRI-SCOPE CONTROLLER

MEAN ACCURACY FIRST

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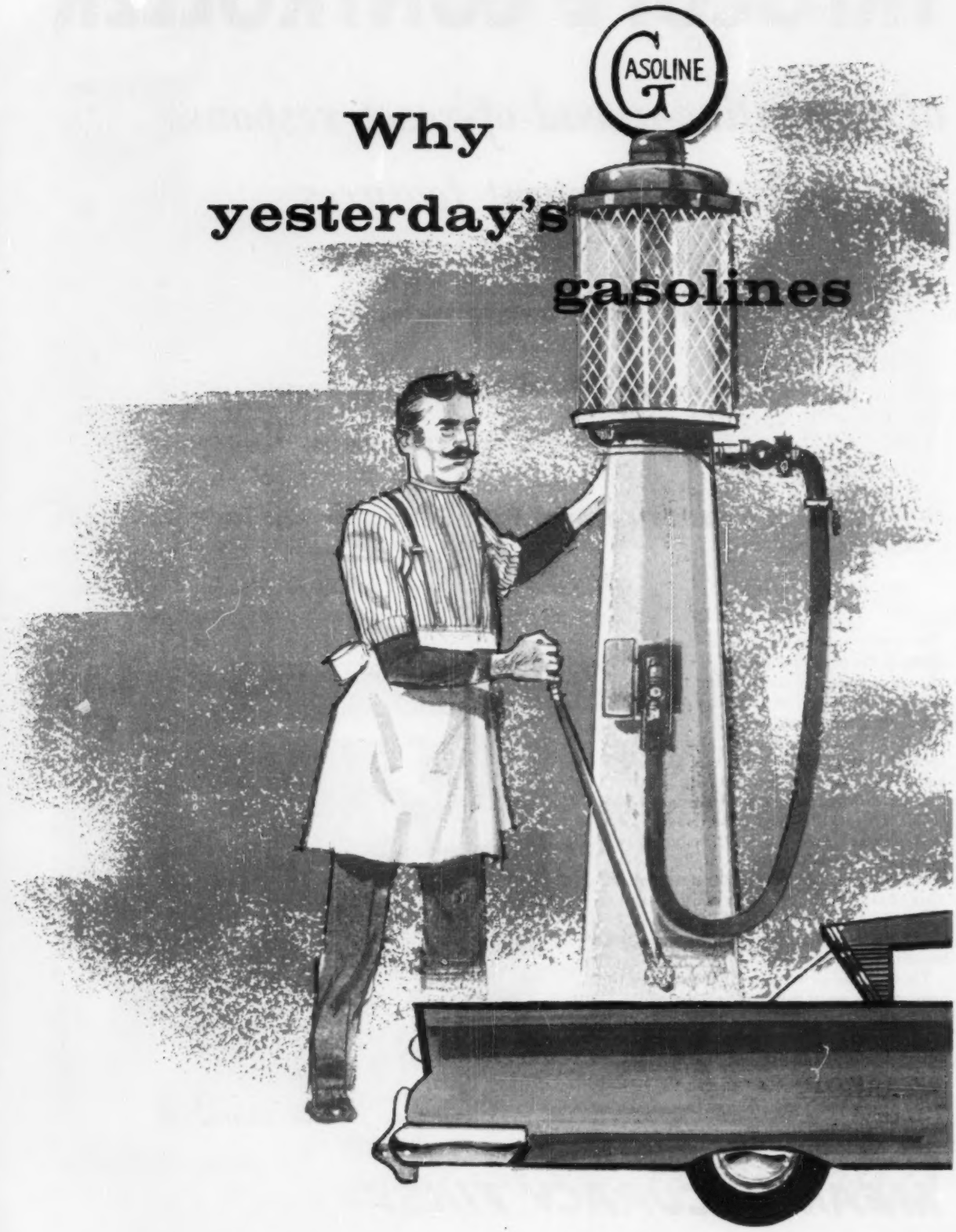
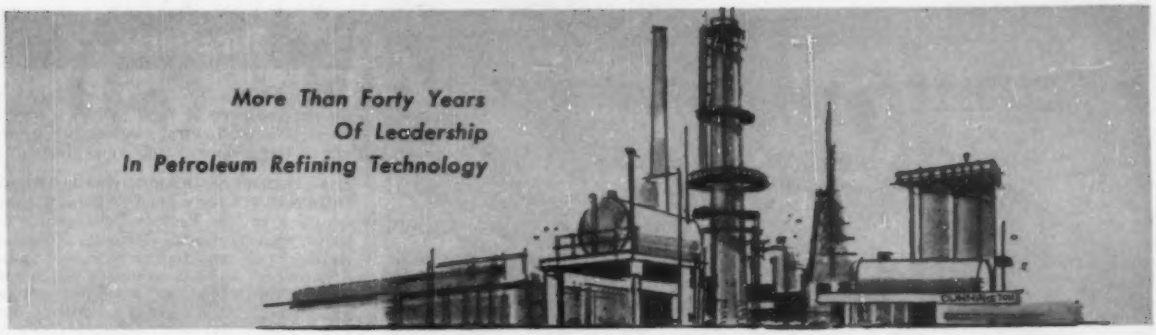
Why yesterday's gasolines





won't power today's cars

Your modern car is a high-precision machine—made possible by high-precision gasoline. Especially refined and formulated for high-compression engines, it is this gasoline that gives today's car its smooth, knock-free power.

Extremely important in the vast strides made in gasoline refining are the services furnished the petroleum industry by Universal.

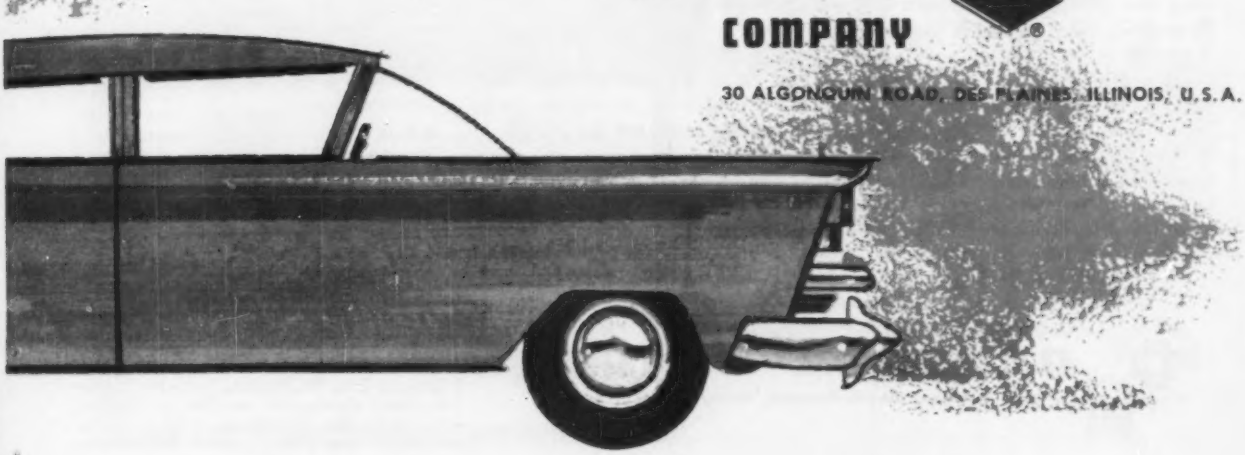
Development of increasingly effective processes and products for producing cleaner-burning, high octane gasoline . . . training of refinery personnel . . . comprehensive field and laboratory service to help the refiner achieve peak operating efficiency and product quality . . . these are among the services rendered by UOP to petroleum refiners the free world over.

It is through services like these that today's gasoline and today's cars have reached their high standards of performance.

UNIVERSAL OIL PRODUCTS COMPANY

UOP®

30 ALGONQUIN ROAD, DES PLAINES, ILLINOIS, U.S.A.



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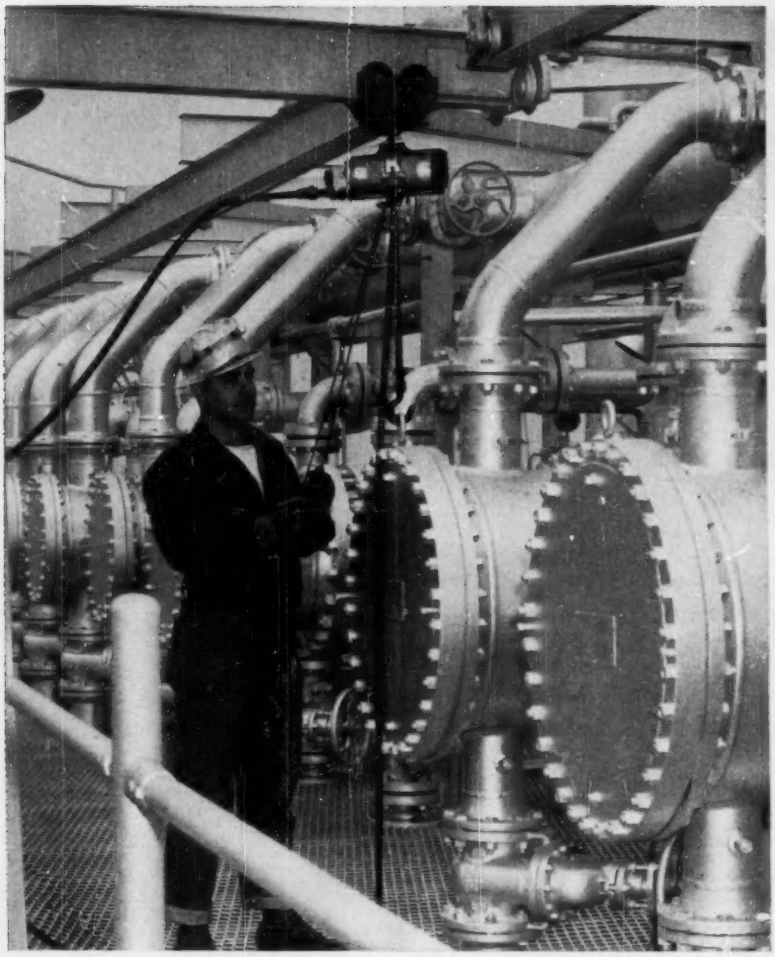


For lifting channel covers, tube bundles, or any heavy lifting job up to two tons, there's a Gardner-Denver air hoist to handle it.

Handy hoist for refinery maintenance

On day-to-day maintenance or during turnaround periods, let Gardner-Denver air hoists lighten your lifting jobs. They're fast, safe, easy to operate. Here's why:

Air motor power—can't be damaged by overload stalls. Can't spark or burn out. Motor is sealed from dirt and corrosive fumes.

Powerful brake—prevents racing, will hold load in complete control even if air line is disconnected.

Load chain—roller or link. Tested to two times maximum rated load. Adjustable safety stops shut hoist off when load is at maximum limit.

Safety hook—made of forged steel . . . ball-bearing mounted for swiveling. Will accommodate load in any position.

Controls—control bar or pendant control system provides effortless one-hand lifting or lowering.

Choose the safe, spark-free lifting power you need from the Gardner-Denver air hoist line. Seven models from 150 lb. to two tons. Write for Bulletin 86.

ENGINEERING FORESIGHT—PROVED ON THE JOB
IN GENERAL INDUSTRY, CONSTRUCTION, PETROLEUM AND MINING

GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois

Suppliers . . .

neer in 1949 at Thibodeaux, La., and district engineer in 1951 at New Orleans. Reed is a mechanical engineering graduate of the University of New Mexico.

THE THOMPSON-RAMO-WOOLDRIDGE PRODUCTS CO. has named **William S. Aiken** manager of the Project Engineering department, Engineering division, and acting manager of the division's Programming department. He has extensive experience in electronic design, analog computers, missile systems, controls, instrumentation, flight test, guidance and radar, and he received a B.S. degree in physics from Yale University, and a M.S. degree in physics from M.I.T.

Young

Gustafson

CLAYTON MARK & CO. has appointed **Walter A. Gustafson** manufacturers sales representative for the Union division, New England States. He has been a sales representative to industrial plants power companies shipyards and wholesalers of power plant mill supplies in New England for ten years.

Richard J. Young will represent the company in the Mid-Atlantic states. Prior to joining Clayton Mark, Young was a field sales engineer with the Quaker Rubber division of H. K. Porter Co. and a sales supervisor with the Minnesota Mining and Manufacturing Co.

EMERY INDUSTRIES, INC. has named **Albert A. Nelson** commercial research manager. He will conduct market studies, sales analysis, and profit and pricing studies. Before joining Emery, he conducted sales research for Gibson Art Co. Nelson has a B.B.A. degree from the University of Cincinnati, and a M.S. degree from Xavier University.

AMERICAN CYANAMID CO.'s Organic Chemicals and Pigments divisions have named **Joan Butler** product publicity supervisor. A graduate of Wellesley College, she joined Cyanamid in 1950 as a scientific editor in the company's laboratories, Stamford, Conn.

W-K-M, a division of ACF Industries, Inc., has named **Glen Tableman** manager of W-K-M Valve Co. (Britain), Ltd. He was previously general sales manager, W-K-M division, Missouri City, Texas.

WOLVERINE TUBE, division of Calumet & Hecla, Inc., has elected **Lloyd G. Fox** vice-chairman of the Pipe and Tube section, Copper and Brass Research Association. He has been with Wolverine in various sales capacities for the last 19 years.

BECKMAN INSTRUMENTS, INC. has appointed **John W. Beavans** controller for its Berkeley division. A graduate in accounting from the University of Indiana, he formerly was division controller for the

For more data on advertised products, use Readers' Service Cards, last page.

IBM offers you . . .

TEN PROVEN PROGRAMS

packaged for small refinery use with the IBM 650

Powerful aid to small refineries

Ten customer-tested programs are now available without cost to small refinery users of the IBM 650 system. These packaged programs permit every refinery to obtain the advantages of electronic computing immediately.

Yours . . . five years of engineering programming effort

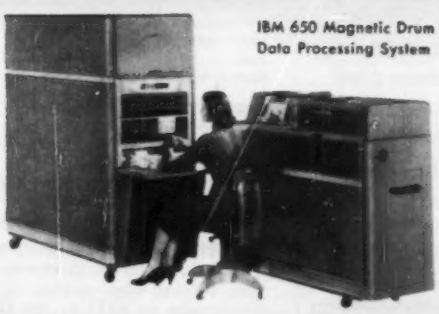
Due to the full cooperation of the petroleum industry, whose extensive experience at more than sixty IBM 650 installations has made these programs possible, you can now get five years of programming effort . . . packaged and ready for your use. For example:

Magnolia's linear programming code

An adaptation of the modified simplex method is used to solve the linear programming model. The program will process problems having a maximum of thirty-four restraints, or row vectors, and an unlimited number of variables, or column vectors. Use is made of a combination of fixed and floating point routines to reach the desired solution. Output results are the basis variables and the shadow prices of the non-basis variables. Running time is difficult to estimate as it depends on the density of the model, as well as the number of rows and columns. A typical problem with thirty-four rows and fifty-seven columns, requiring thirty-four iterations, ran in one hour and forty minutes. Approximately two man-months were required for programming.

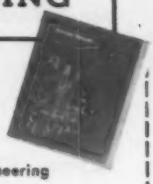
Booklet describes programs in package

SEND for the new booklet, "Proven Engineering Programs for Petroleum Refineries." Get detailed explanations of how all 10 of these powerful engineering programs can benefit your operations.



IBM 650 Magnetic Drum Data Processing System

IBM DATA PROCESSING



PETROLEUM DEPARTMENT A58-d,
International Business Machines Corporation,
590 Madison Avenue, New York 22, New York

Please send me the free booklet, "Proven Engineering Programs for Petroleum Refineries."

Name_____

Position_____

Company_____

Address_____

City_____ State_____

For more data on advertised products, use Readers' Service Cards, last page.

Here's How to Handle Corrosives at High Peripheral Speeds

CHEMLON YARN PACKING STYLE C-30 Made of TEFLON* FIBER BY "JOHN CRANE"

Chemlon Yarn Style C-30 extra tough packing gives you two important advantages not provided by other types of braided or molded Teflon packing: 1) positive sealing efficiency at high peripheral speeds; 2) cooler running stuffing box under severe service conditions.

Style C-30 can be used to handle the most destructive acids, alkalis or solvents. The excellent thermal properties of Teflon, combined with the softness, resiliency and fluid retentive properties of fine fiber construction, adapt it to high temperature conditions to +300°F. The packing is made firm and dense by means of a special process which eliminates *large* voids.

HERE'S PERFORMANCE PROOF:—Fluid handled: 45% H_2SO_4 (impure) at 170°F.—Operating conditions: 1¼" pump shaft at 1700 rpm. or 555 fpm. peripheral speed. Results: 46 days good service. Previous best service record 7 to 10 days.

Chemlon Yarn Packing Style C-30 is available in spool or coil form, in a wide range of sizes from ⅛" up. *Can be lubricated with Teflon suspensoid or various types of lubricants.*

Send for Bulletin No. P-325, Crane Packing Co., 6420 Oakton St., Morton Grove, Ill., (Chicago Suburb). In Canada: Crane Packing Co., Ltd., Hamilton, Ont.

* *DuPont Trademark*

John Crane **CRANE PACKING COMPANY**

Suppliers . . .

Metal Products division of Ball Brothers, Inc., Muncie, Ind. He also was with General Electric Co. and with Magnavox Co. in various accounting capacities.

Burkstaller

Adams

COOPER-BESSEMER CORP.'s New Orleans field office has two new sales engineers—**William J. Burkstaller** and **Gilbreth D. Adams.** Formerly with the Odessa office, Burkstaller will work in the New Orleans area. He is a graduate in mechanical engineering from the University of Missouri.

Adams will assist in engineering and sales in the Louisiana area. A graduate in petroleum engineering from the University of Texas, he has been with Cooper-Bessemer since 1956 at Mount Vernon, Ohio.

CRANE CO. has elected **Norman F. Garrett** vice president and general manager of manufacturing. He has been general manager of the company's Chicago Manufacturing division since January, 1957. He will direct operations of all Crane Co. plants. Before joining Crane, Garrett was vice president for operations of Motor Products Corp.

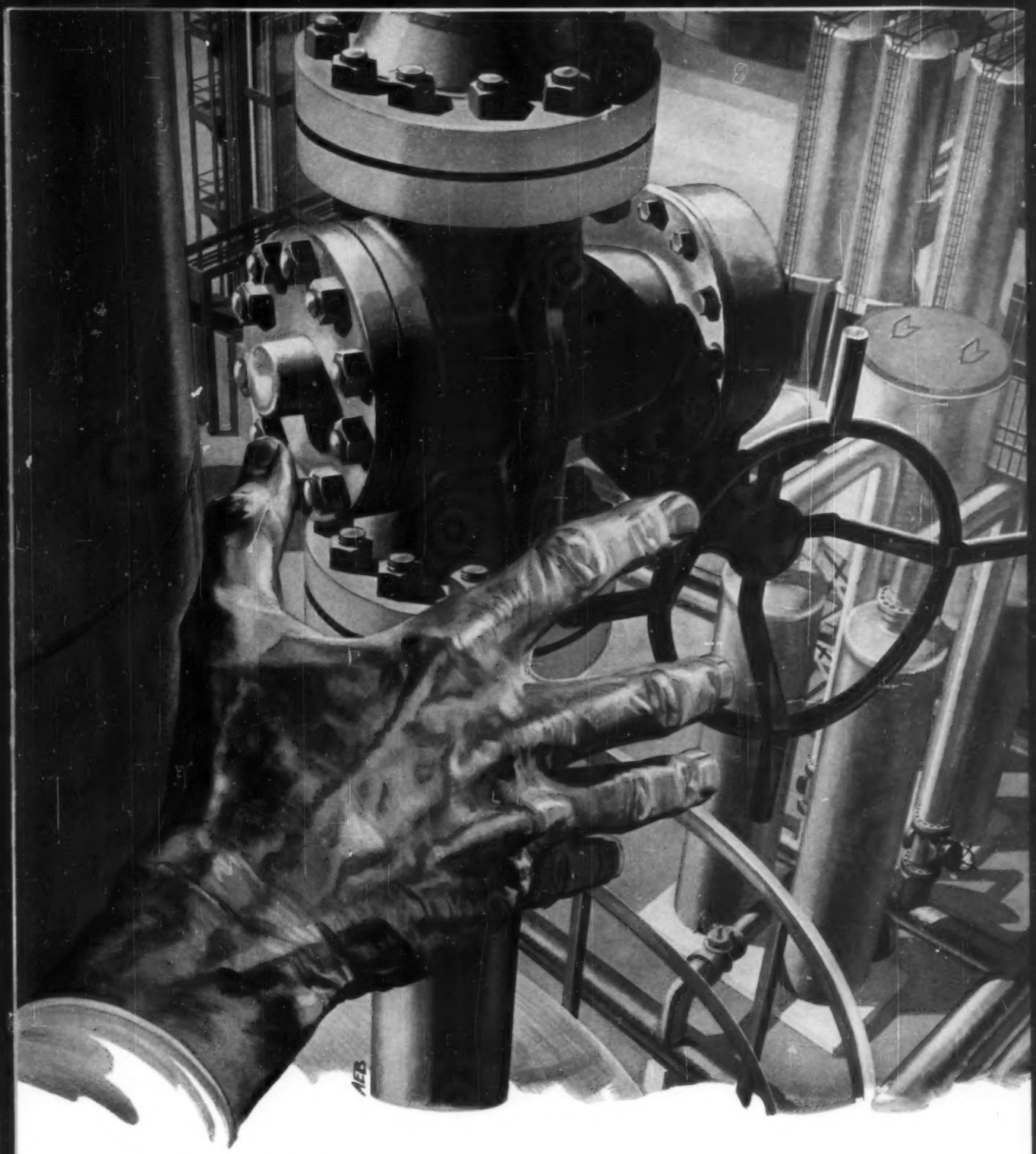
BJ SERVICE, INC., a Borg-Warner subsidiary, has named **John B. Merritt** president and chief executive officer. He has been executive vice president and general manager of BJ Service since 1951, having begun his career within Byron Jackson division in 1941. Merritt was formerly general manager of Byron Jackson's Oil Field and Industrial Rubber division.

AMERICAN CYANAMID CO.'s Rubber Chemicals department has appointed **George J. Sella, Jr.,** a product manager. He will be in charge of commercial development of antioxidants and chemicals for the synthetic rubber industry. Sella joined Cyanamid in 1954. He is a graduate of Princeton and Harvard Universities, and a member of AIChE and ACS.

MEXICO REFRACTORIES CO. is planning construction of a complete new $2 million refractories plant near Stockton, Calif. It also announced a $1 million modernization of its Mexico, Mo., plant to be completed by the end of 1958.

PYROMETER CO. OF AMERICA has named **Norman E. Bonn** director of research. He is a graduate of the University of Pittsburgh and has specialized in developing precision measuring techniques and apparatus. He was formerly director of research for the Rubicon Instrument Co.

U. S. STEEL CORP.'s Oil Well Supply division has named **D. O. Smith** area manager, tubular sales, at Houston. He joined the division in 1924 at Oil City, Pa., in the engineering department. In 1934 he was appointed store manager at Bolivar,



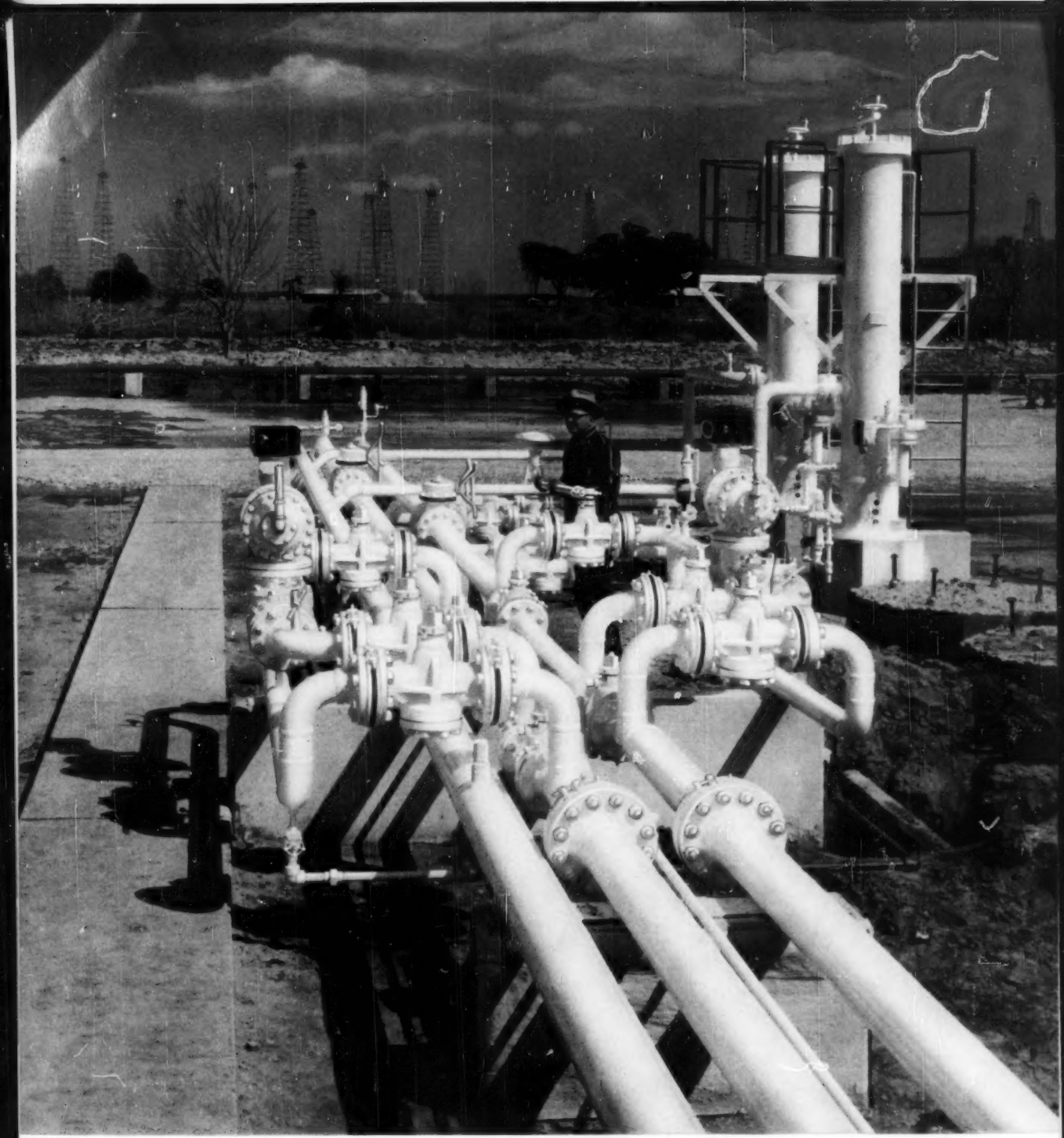
OUT BY ITSELF, this valve is too inaccessible to be pampered if it won't work. It's on services like this that you so often see Rockwell-Nordstrom lubricated plug valves. Why? Pressurized lubricant forms a *leakproof seal*, prevents wear, keeps the quarter-turn operation smooth and easy. Proved on tough services, Rockwell-Nordstrom valves naturally work better, stay in service longer and cost less to use.

Available everywhere in a *complete* range of sizes and pressures. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

ROCKWELL-Nordstrom VALVES

it's ROCKWELL

MANUFACTURING COMPANY



HOW GOOD IS SECOND BEST?

In the oil, gas or process industries, second best is not good enough. That's why you see so many Rockwell-Nordstrom valves where only the *best* is acceptable for critical flow control. Their positive shut-off, easy operation and long-life economy just can't be equaled.

Rockwell-Nordstrom is the world's most complete line of lubricated plug valves and plug valve accessories. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

ROCKWELL-Nordstrom VALVES

it's ROCKWELL

MANUFACTURING COMPANY

Suppliers . . .

N. Y., and in 1949 became district manager at Oklahoma City. He became assistant area manager at Houston in 1952 and held this position until his present appointment. Smith studied mechanical engineering at Pennsylvania State College.

PREFORMED METAL PRODUCTS CO., INC. has had a controlling interest in its stock purchased by **Travis Campbell**, Dallas business man and investor. Campbell, who has assumed the presidency of the company, purchased 56 percent of the outstanding shares from **R. R. Brinkman, Jr.**, one of Premetco's founders. Balance of the outstanding stock in the closed corporation is owned by **V. R. Dunn**, newly elected Premetco vice president and general manager. General offices and the plant will remain at their present locations in Shreveport. Dunn has been with Premetco since its founding.

Dunn

ALLIS-CHALMERS MANUFACTURING CO's J. E. Watson, Jr., former manager of the Miami district, has been appointed manager of the firm's New Orleans district. He joined the company in 1949 and was a representative in the Birmingham office before being transferred to Miami in 1951. Watson has a B.S. degree in electrical engineering from Duke University and is a member of AIEE.

HARBISON-WALKER REFRACTORIES CO.'s board of directors has appointed **A. Brent Wilson** executive vice president of the **A. L. Garber** will remain president and chief executive officer, and Wilson will assist him and perform the duties of president in his absence.

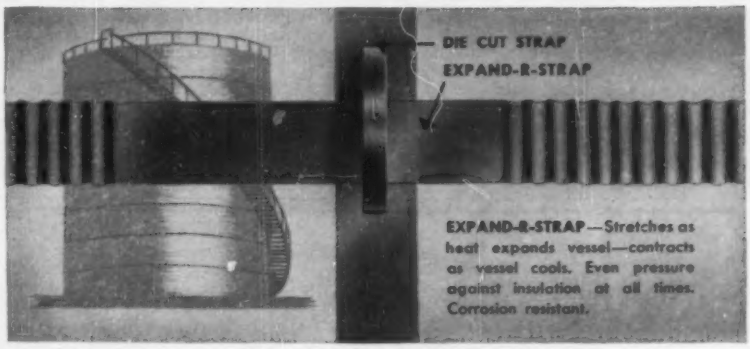
Wilson joined Canadian Refractories Ltd., Harbison-Walker's Canadian subsidiary, in 1934, shortly after graduation from Queen's University, Kingston, Ontario. He became general manager of Canadian Refractories Ltd. in 1948 and was transferred to the office of the parent company in 1950. He became vice president of that company in 1955.

Wilson

CLARK BROS. CO. has appointed **George L. O'Connor** to a newly created post for the promotion and sale of company products in the eastern half of the U. S. He joined the company from Houston, where he was formerly equipment engineer for The Lummus Co. He has had experience in handling diversified customer requirements.

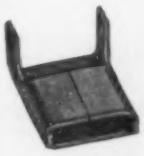
THE THOMPSON-RAMO-WOOLDRIDGE PRODUCTS CO. has appointed **Charles G. Laspe** associate manager of the Process Applications department, Engineering division. A petroleum refining engineer, Laspe has experience in processing. For-

NOW! One source for ALL your strapping needs

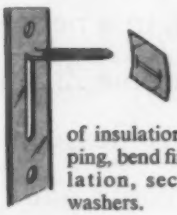

DIE CUT STRAP
EXPAND-R-STRAP
EXPAND-R-STRAP—Stretches as heat expands vessel—contracts as vessel cools. Even pressure against insulation at all times. Corrosion resistant.

ALLOY STRAPPING
For all types of insulation and varying corrosive conditions.

TENSIONING TOOLS
A full range of highest quality—easiest to use strapping tools.



ALLOY SEALS
Stainless steel, aluminum, galvanized, brass and monel seals for all widths and sizes of strapping.



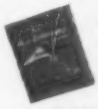
FINGER STRAPPING
For all thicknesses and types of insulation. Apply as strapping, bend fingers, impale insulation, secure with spring washers.

WIRE—STAPLES & PINS
Available in all alloy grades.

SPACERS & CLAMPS

Especially designed for steam tracer lines.

A. J. GERRARD AND COMPANY
1956 Hawthorne Court • MELROSE PARK, ILLINOIS



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COMPANY _____
NAME _____ TITLE _____
ADDRESS _____
CITY _____ ZONE _____ STATE _____

For more data on advertised products, use Readers' Service Cards, last page.

Suppliers . . .

merly with Shell Oil Co., Wilmington, he was an oil technologist, a research technologist in physical chemistry, and instrumentation engineer in process instrumentation.

ETHYL CORP.'s Charles M. Gambrill, analytical coordinator at the research laboratories in Detroit, has received the 1958 "Anachem Award in Analytical Chemistry" of the Association of Analytical Chemists, and presented the award address at the Association's sixth annual conference. Gambrill has been with Ethyl since 1928, and for 20 years served as head of the Analytical section of its Detroit research laboratories.

ARMSTRONG SIDDELEY MOTORS, LTD., of London, and Clark Bros. Co. have signed a manufacturing agreement providing for licensed manufacture in the United Kingdom of gas turbines designed and made by Clarke in the U. S. Armstrong is an automotive and jet engine manufacturer.

COOPER-BESSEMER CORP. has named **Phil S. Hurst** assistant product manager, gas engine compressor sales. A graduate of Oklahoma State University, he has a B.S. degree in chemical engineering. Since graduation he has been with the Sales Engineering section.

BORG-WARNER CORP.'s Byron Jackson division has named company president **E. S. Dulin** chairman of the board. **Andrew W. Rose** succeeds him as president and chief executive officer of this Borg-Warner division.

Strahmaier

Lindeman

PENBERTHY MANUFACTURING CO. OF DETROIT, a division of Buffalo-Eclipse Corp., has appointed **Howard E. Strohmaier** general manager, and **Arnold N. Lindeman** general sales manager. Both men have been with Penberthy for more than 20 years. Strohmaier served in the sales program, being general sales manager before his promotion. Lindeman was chief engineer with the company.

PROCESS OPERATORS, INC., a new service organization in Houston, has been formed to provide the refining and chemical industries with a large staff of operating specialists. The firm reports that it is equipped to take large and small operations, and can handle performance test runs and startup on any type of new process plant.

UNION TANK CAR CO. has completed a new regional tank car repair and maintenance facility in Baton Rouge. The dome-shaped structure is designed geodesically. It has no internal supports whatever and is big enough inside to hold either a football field or baseball diamond.

JONES & LAUGHLIN STEEL CORP. has completed new stainless steel sheets and strip facilities at its $17 million Stainless and Strip division plant, Louisville, Ohio.

COOPEER-BESSEMER CORP.'s G. W. Gilchrist, representing the U. S. at the 7th International Conference of S. G. iron licensees at Brussels, has presented a paper on the development of riserless ductile iron castings. It reported on accomplishments to date using this ductile iron casting technique. Presently assistant works manager of Cooper-Bessemer, Gilchrist has been worked in several ductile iron development programs. With a B.S. degree in chemical engineering, he joined Cooper-Bessemer in 1940 and has since been foundry engineer, assistant foundry superintendent, and foundry superintendent. He became assistant works manager in 1957.

Gilchrist

THE YOUNGSTOWN SHEET AND TUBE CO. will revamp the 79-inch hot strip mill at its Campbell plant in a two-year program that will cost more than $50 million.

MINNEAPOLIS-HONEYWELL INSTRUMENT CO.'s Brown Instruments division has appointed **John B. Moxness** market manager for pyrometer supplies and accessories. He joined the firm in 1946 as sales correspondent and has served since in various capacities. His most recent post was ad-

When Was Zinc Chromate First Used in Corrosion Inhibitors?

Over 10 years ago, in 1947, Wright introduced the use of zinc, for corrosion control, in a new Wright product called Penechrome Z. Since then other Wright Penechromes, containing zinc chromate and organic additives, have proved in years of field service the greater effectiveness of zinc-containing corrosion inhibitors. Wright research, as always, will continue developing new approaches to the solution of your water side corrosion problems.

Ask about Wright Consulting Services.

Wright CHEMICALS

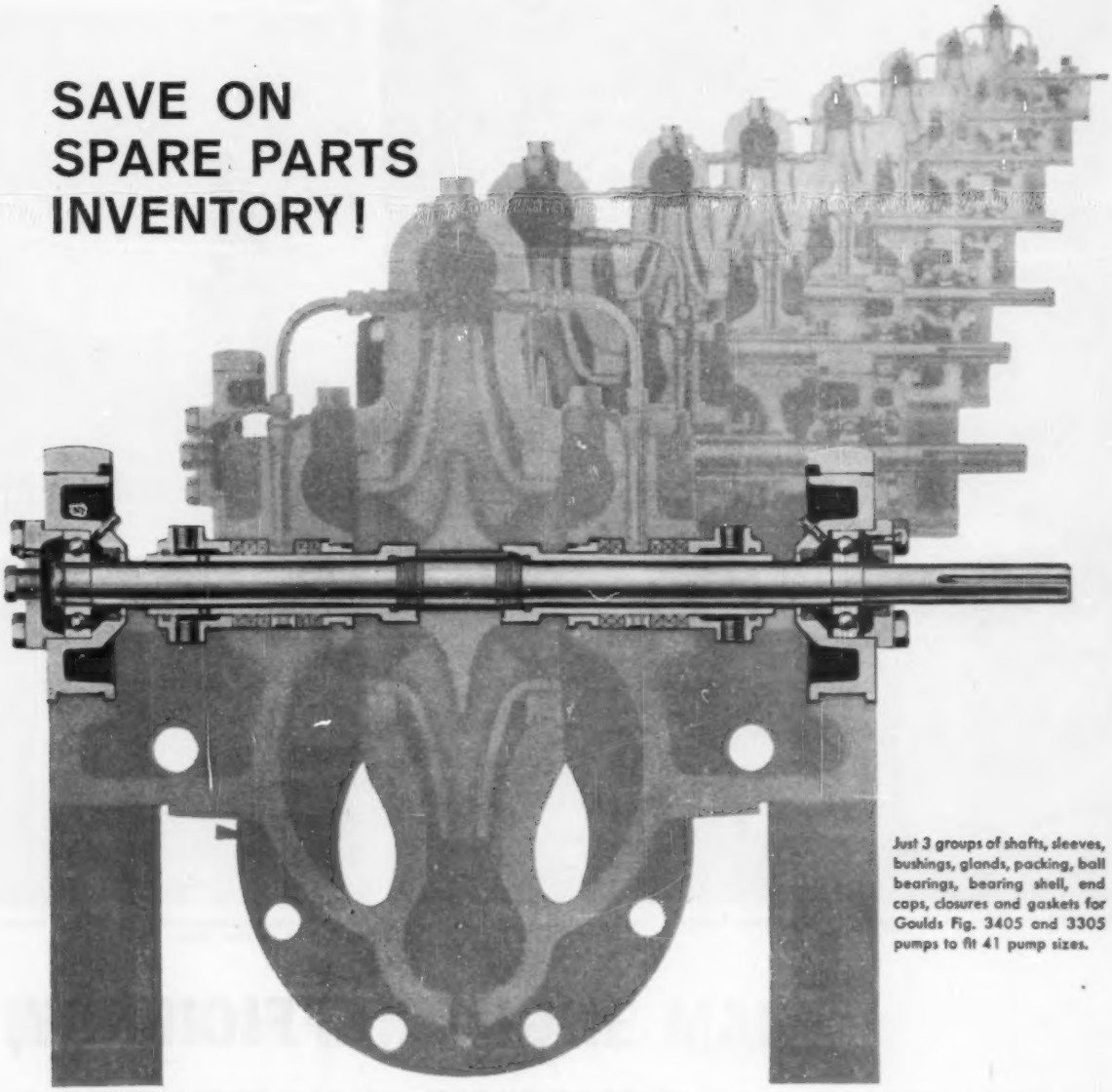
WRIGHT CHEMICAL CORPORATION

GENERAL OFFICES AND LABORATORY
633 WEST LAKE STREET, CHICAGO 6, ILLINOIS
Offices in Principal Cities

- Softeners, Filters and other external Treating Equipment
- Nelson Chemical Proportioning Pumps

For more data on advertised products, use Readers' Service Cards, last page.

SAVE ON SPARE PARTS INVENTORY!



Just 3 groups of shafts, sleeves, bushings, glands, packing, ball bearings, bearing shell, end caps, closures and gaskets for Goulds Fig. 3405 and 3305 pumps to fit 41 pump sizes.

See how just 3 groups of parts fit 41 pump sizes!

High degree of interchangeability of parts on Goulds Fig. 3405 single-stage and Fig. 3305 two-stage Centrifugal Pumps helps you save four ways:

1. You cut down your spare parts inventory.
2. You can make changes in the field to meet new requirements.
3. Off-the-shelf delivery of standardized parts.
4. You can get lower initial cost, due to standardization of parts during manufacture.

Just three shaft and rotating parts assemblies provide for 41 sizes of these two popular pumps. You cut spare parts inventories *up to 91%*, save the cost of unnecessary overstocking.

Up to 82 pump combinations are possible—considering right- and left-hand rotation—and rotation can be changed in the field due to unique sleeve locking device (patented). Mounting dimensions and motor drive bedplates are standardized to facilitate changing without the additional expense of drilling and tapping.

And . . . you get all of this at low cost! Standard parts make manufacture less costly. Goulds passes on the savings to you.

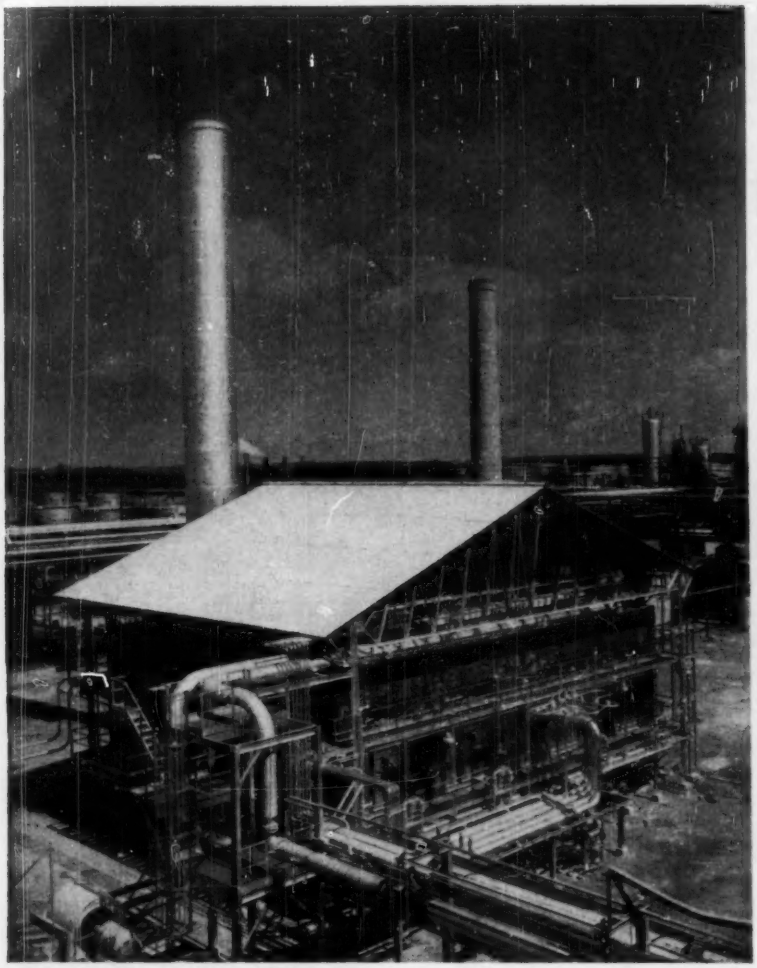
Find out how this maximum interchangeability can save you money by sending for Bulletins 721.6 and 722.6, or ask your nearest Goulds representative.

GOULDS PUMPS, INC., Dept. PR-128, Seneca Falls, N. Y.

GOULDS

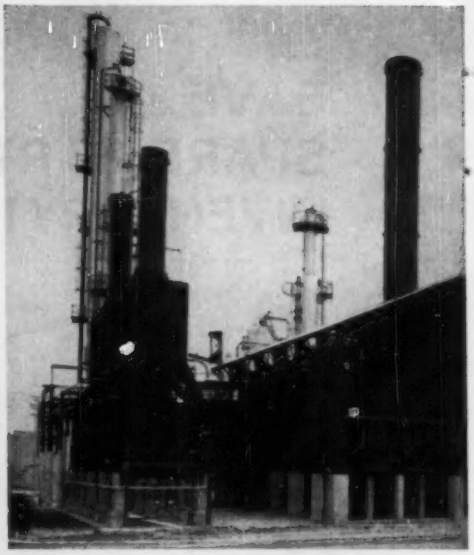
PUMPS FOR INDUSTRY

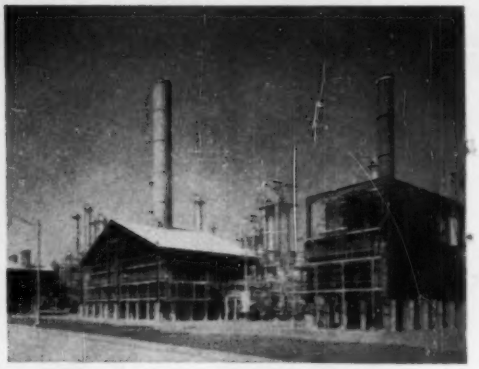
For more data on advertised products, use Readers' Service Cards, last page.



Portable crude heater for Magnolia Petroleum Company, Beaumont, Texas.

Ultraformer heater for American Oil Co. at El Dorado, Arkansas.





Platformer and desulphurizer heaters for Shell Oil Co. at Deer Park, Houston, Texas.

HIGHER EFFICIENCY, LUMMUS OIL HEATERS

Lummus designs horizontal and vertical-tube oil heaters to any size, for any process—anywhere in the world.

Major refiners confidently turn to Lummus on their important and difficult oil heater jobs.

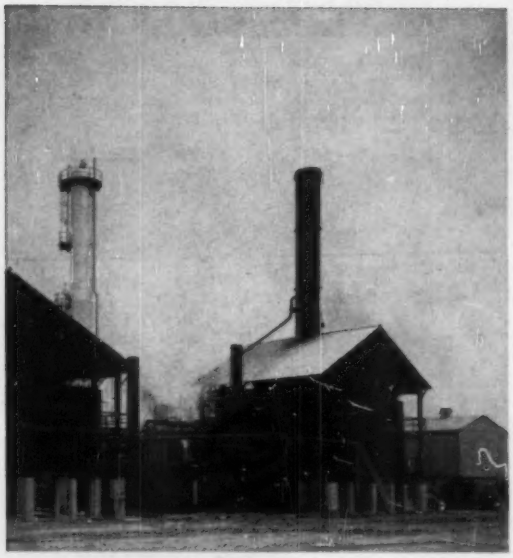
In the last 25 years, the combined capacity of all Lummus oil heaters built has exceeded that of any other company in the world. The reasons: greater durability, more efficient operation, an absolute minimum of days lost to downtime.

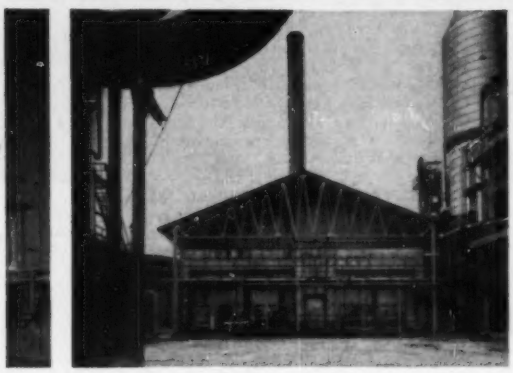
Major refiners maintain large engineering and economics staffs who can evaluate the performance of important heating equipment. They buy more Lummus oil heaters because they *know* through statistical comparison that Lummus gives them *more heater per dollar.*

In 1957 alone, Lummus received contracts to engineer more than 130 oil heaters, with a combined absorbed-capacity of over 7,000,000,000 Btu per hour — the largest number of units and highest overall capacity in Lummus' oil heater history!

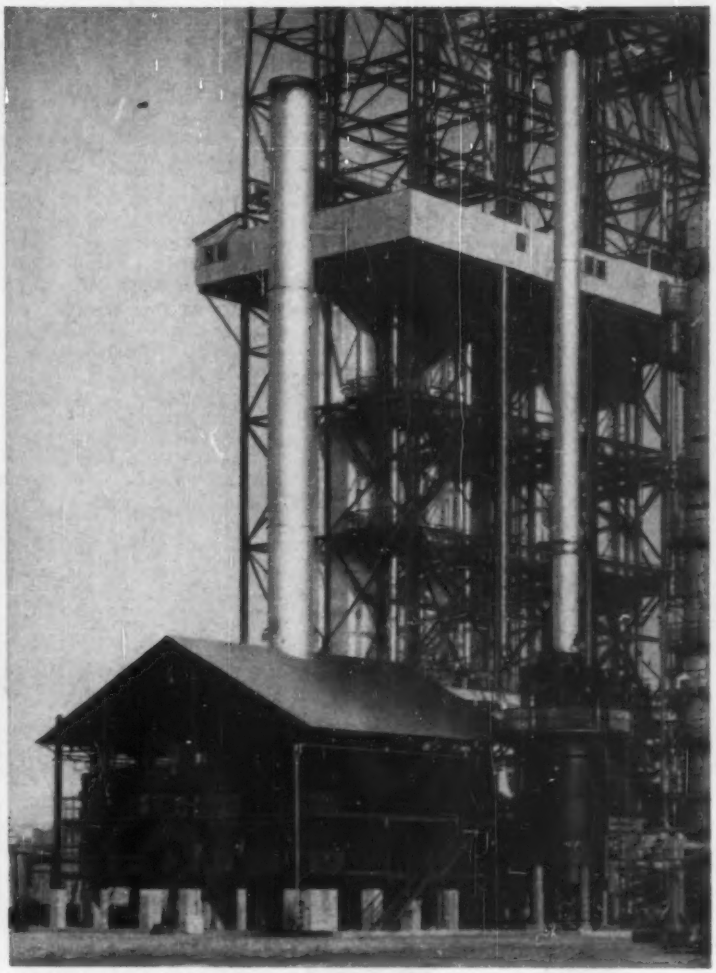
Lummus offers over a quarter of a century of oil heater experience for petroleum refineries, chemical and petrochemical plants. The highly trained engineering staff of the Oil Heater Division is ready in the Lummus New York office to give each job the full benefit of its accumulated know-how in this field.

Lummus oil heaters, of both special and standard design, range from 100,000 to 300,000,000 Btu per hour. As illustrated above, neither size, type nor location of the unit presents a problem to Lummus. Because Lummus offers *every* type of oil heater,





Crude heater for Socony Mobil at Paulsboro, N. J.



Delayed coker heater for the American Oil Co. at Yorktown, Virginia.

MINIMUM DOWNTIME MAKE PREFERRED AMONG MAJOR REFINERS

you can be sure that we will recommend the *right* unit for your needs. Complete Lummus facilities are available world-wide through any of the five international Lummus companies. Equipment is designed in New York, procurement is made through the nearest Lummus international office, and the cost of the job is payable in the currency of the country in which the procurement is handled!

Consult with Lummus on your next oil heater — large or small.

LUMMUS

THE LUMMUS COMPANY, OIL HEATER DIVISION
385 MADISON AVENUE, NEW YORK 17, N. Y.

WASHINGTON, D. C. • CHICAGO • HOUSTON • MONTREAL • CARACAS • MARACAIBO • LONDON • PARIS • THE HAGUE

For more data on advertised products, use Readers' Service Cards, last page.

DEKORON PROTECTO-PAC

Advantages of Dekoron all-plastic instrument tubing harness are *now four-dimensional*. You get, in addition to its inherent lower-cost installation . . . chemical . . . impact . . . fire resistance.

And the advantages of Dekoron Protecto-Pac multiply the closer you examine them. For example, you can get Protecto-Pac in many forms to suit your requirements exactly — *from stock.*

If there is danger from weld splatter, sparks or a potential fire hazard — order Dekoron Protecto-Pac Type FB. If you wish to bury it underground — specify low-cost Protecto-Pac Type B. Both types supplied with virtually any number of individual tubes, and also with *new metal armor protection.*

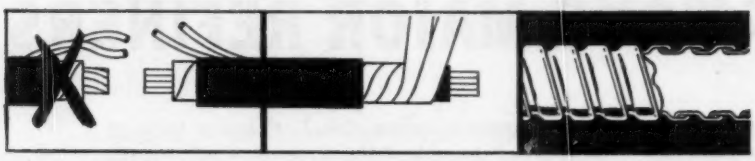
You can pay more but you can't buy better, longer-lasting instrument line harness than *Dekoron — America's Premier Instrument Tubing Line.*

AA-5885

TYPE FB
FOR FIRE AND IMPACT RESISTANCE

FIRE RESISTANCE of copper tube bundles is superior up to 1900°F; less pronounced from 1900° to 2500°F. Above 2500° Protecto-Pac Type FB is superior to copper tube bundle.

TYPE B
FOR UNDERGROUND BURIAL



NO "CORKSCREW" effect, as with twisted tubes, because tubes lie straight in bundle to give faster, neater individual tube take-offs.

NEW IMPROVED INSULATION is composed of two wraps of asbestos tape bonded to backing of Mylar® for maximum protection.

DEKORON PROTECTO-PAC Type FB or Type B can be supplied with 24 gauge galvanized steel armor of modified square-lock construction with cord packing for maximum strength and flexibility.

Dekoron® products QUALITY • RESEARCH • SERVICE

SAMUEL MOORE & COMPANY • DEKORON PRODUCTS DIVISION • MANTUA, OHIO

Suppliers . . .

ministrative assistant to the manager of the company's Wabash, Ind., plant. He has a mechanical engineering degree from the University of Minnesota.

Comerford

Morrison

THE CARPENTER STEEL CO. has named **Barclay Morrison** assistant marketing manager, with part-time duties on the firm's Reading, Pa., sales staff and Alloy Tube division sales staff, Union N. J. He will also continue to head the Product Engineering and development department, Tube division. **W. J. Comerford** has been promoted to assistant manager of the Product Engineering and Development department to aid Morrison. Before joining Carpenter, he was a field engineer for International Business Machines, and an assistant to the vice president of National Lock Washer Co.

BADGER MANUFACTURING CO. has become sole owner of Badger-Comprimo N. V. by acquiring for an undisclosed amount the 50 percent interest in the firm held by Comprimo N. V., Amsterdam. Effective with the sale, the subsidiary's name has been changed to Badger N. V.

GRAVER WATER CONDITIONING CO. has named **G. M. Wallace & Co.** engineering representatives for the Rocky Mountain-Intermountain area. They will handle Graver's complete line of equipment.

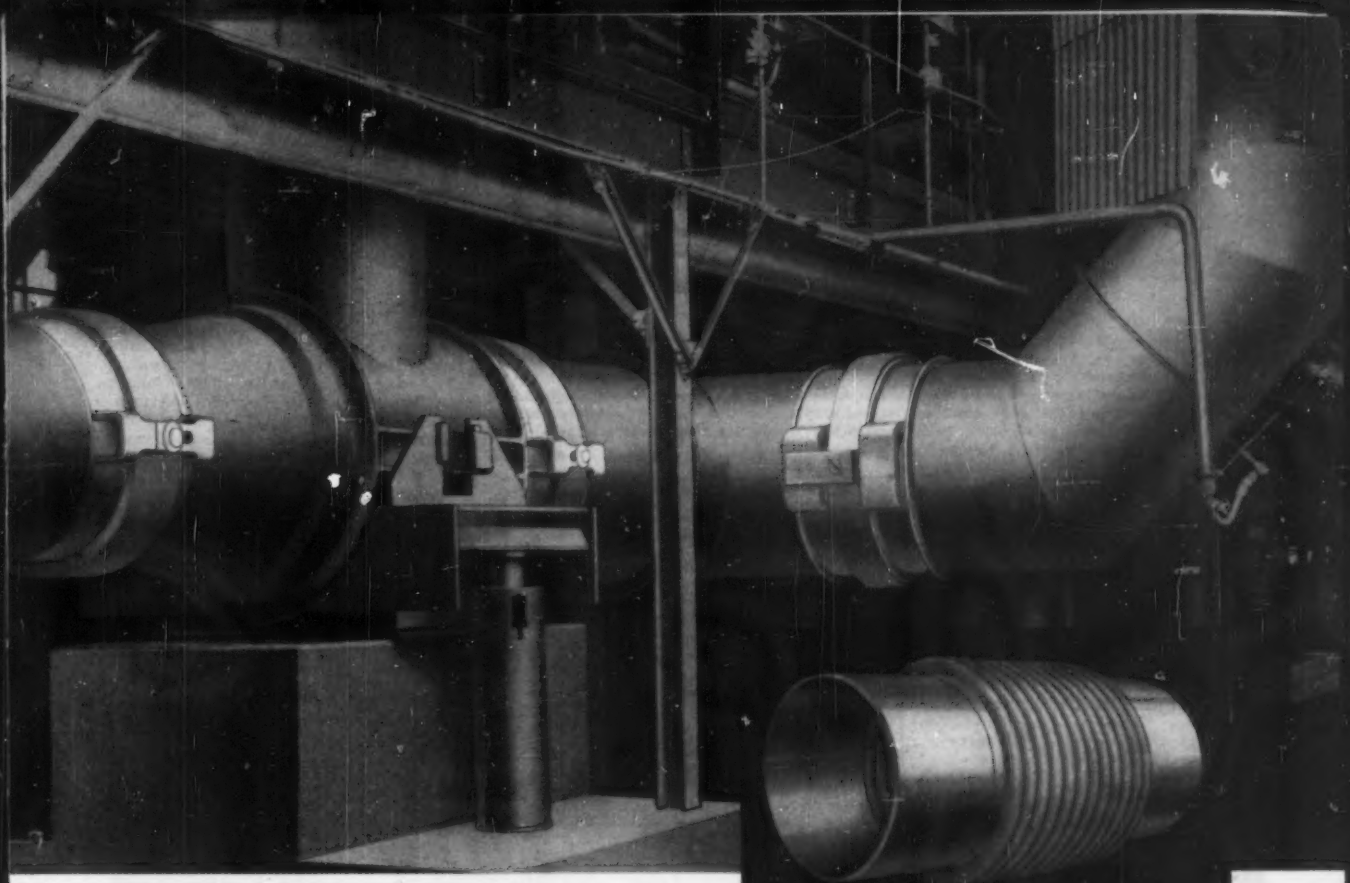
THE OHIO INJECTOR CO. has been awarded a contract by the Atomic Energy Commission for development of a device to control the sodium coolant in fast breeder power reactors. The company will start immediately to design and construct a major test flow facility at its headquarters.

U. S. STEEL CORP.'s Oil Well Supply division has named **Charles E. Rocheville** manager of the division's Neilsen Pump works, Long Beach, Calif. He joined Neilsen Pump in 1936 in the Engineering department, and was appointed assistant to the works manager in 1952, and manufacturing coordinator of sub-surface equipment in 1955.

MONSANTO CHEMICAL CO. has named **Harlan A. Hashbarger,** manager of production planning and control for the Organic Chemicals division, to the new position of director of divisional planning. His responsibilities will include evaluating and coordinating new manufacturing projects, liaison with the Corporate Planning group in long-range divisional planning, and handling special projects in divisional administration.

THE BRIGGS FILTRATION CO. has named **James M. Canaris** director of engineering. He has been a member of the Briggs sales-engineering staff since 1956, prior to

For more data on advertised products, use Readers' Service Cards, last page.



View of hydrocarbon outlet line just below reactors shows three of a total of 67 Badger S-R Expansion Joints at Firestone's new Butadiene Plant at Orange, Texas. Joints shown are equipped with guide bars and external covers.

Series 50W S-R Expansion Joint
Shown with cover removed.

Badger S-R Expansion Joints handle rugged 1100° service at Firestone's new plant

The Houdry process used at Firestone Tire and Rubber Company's new Butadiene Plant calls for temperatures up to 1100°. Add critical forces on anchors and connected equipment, wind loading, and complex piping arrangements and you have real problems in piping and expansion joint design.

Working together with Catalytic Construction Co. and Firestone, Badger solved these problems with new Service-Rated (S-R) Expansion Joints. In all, sixty-seven joints have been installed, all of the new Series 50 (low pressure) S-R design. Ranging in size from 30″ to 72″, the joints are arranged singly or in systems of hinged and tandem types to absorb and control pipe line movement (which, due to the piping arrangement, is often axial and lateral — in *two different directions*). Stainless steel bellows are used in all joints; welding nipples are stainless or carbon steel depending on temperatures to be encountered.

Here is another example of a severe pipe expansion problem Badger S-R Expansion Joints and engineering experience have solved successfully. Find out more about the ways they can help you — write today for illustrated brochure.

New corrugation and ring designs produce better equalization, "all-curve" flexing

Curvilinear Corrugations used in S-R Expansion Joints were developed by the Badger Research Department. Under operating pressures (white line) the new design produces more uniform movement per corrugation and natural "all-curve" flexing. Stress is reduced... life increased.

Series 50 corrugation cross-section

S-R Joints for higher pressures have tubular Reinforcing Rings. These new rings make metal-to-metal contact only in the "valley" of each corrugation allowing natural "all-curve" flexing (white line). Tubular shape permits greater effective flexing height which contributes to longer life.

Series 150 corrugation and ring cross-section

BADGER

S·R

SERVICE RATED

EXPANSION JOINTS

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BADGER MANUFACTURING COMPANY
230 Bent St., Cambridge 41, Mass. • 60 East 42nd St., New York, New York
Representatives in Principal Cities

Petroleum Refiner New Classified Rates

RATES: Regular Classified (undisplayed) set in this type: 20 cents per word. Minimum charge, $4. Blind box address in our care counts six words. Replies forwarded without charge. Display Classified ads, set in suitably larger type with ruled border, $12.50 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. All Classified ads payable in advance. Copy deadline: 25th of month preceding date of issue. Send copy and checks to: Classified Advertising, Petroleum Refiner, P. O. Box 2608, Houston, Texas.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

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Specify SAUEREISEN
ACIDPROOF CEMENTS—COMPOUNDS
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Tanks, Sewers, Stacks, Floors
Technical cements for all purposes.
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When you see a large chimney think of Sauereisen Cements.

28—WALWORTH GATE VALVES. Model 841 F—8" 500 P.S.I. Lot $5,040 or $190 each F.O.B. New & Perfect.

1—WORTHINGTON STEAM RECIPROCATING PUMP. Size—inches 5¼ x 3½ x 5. $210. New and Perfect.

Write P. O. Box #5
WOOD RIVER, ILLINOIS

HELP WANTED

"We have served technical men and the refining industry since 1947."

DIXIE EMPLOYMENT SERVICE
505 South Coast Building
Houston, Texas

■ West German Engineer, 44, single, entering the USA at the end 1958 with living and working license, offers 15 years experience in design, calculation, processing techniques and plant construction supervision of refineries and chemical plants. Languages German-English-Spanish. U.S.A. or overseas area, living in South America. Box 304-R, PETROLEUM REFINER, Houston, Texas.

■ Research Director, British, 20 years industrial experience, desires suitable and interesting position in U.S.A. Wide experience petroleum chemicals, plastics, organic intermediates. Excellent academic background, publications and patents. Familiar with U.S. industrial conditions. U.S. references. Reply Box No. 305-R, PETROLEUM REFINER, Houston, Texas.

■ PROCESS ENGINEER. Chemical Engineers with experience in Petroleum Refining sought by "America's Fastest Growing Oil Company." Send complete resume, including salary requirements, to Employee Relations Department, P. O. Box 2039, Tulsa, Oklahoma. All replies confidential.

CHEMICAL ENGINEER

Stimulating, creative career in Electronic Computer sales to Petroleum - Petro-Chemical & Chemical Industries

Computer Applications Engineer

IMMEDIATE OPENING IN HOUSTON, TEXAS

QUALIFICATIONS—B.S., M.S., or Ph.D. degree in Chem. Engineering. Minimum of 2 years experience in Technical aspects of Industry. Minimum of one year's experience in Digital Computers. Should have excellent understanding of and experience in Linear Programming. This job requires a man with genuine initiative, plus an interest in sales to lend Technical assistance to highly qualified salesmen throughout Southwest area. Excellent opportunity for advancement with one of fastest growing National Concerns in Electronics Today. Hospitalization, Group Life, Pension and Educational benefits.

ROYAL McBEE CORPORATION
Data Processing Division
P. O. Box 6423 Houston, Texas

WANTED

■ West Coast Warehousing Distributor of Stainless and Alloy pipe valves and fittings requires additional lines and specialties for aircraft, missile, refinery and Food Industries. Box 300-R, PETROLEUM REFINER, Houston 1, Texas.

■ PETROLEUM REFINER back issues and files wanted to buy for cash, also other technical journals. P. R. Ashley, 27 East 21, New York 10, N. Y.

If You Want
Fast
Results . . . be
Sure
to
Use
Petroleum
Refiner
Classified Ads
They Don't Cost,
They Pay!

Suppliers . . .

which he served as vice president in charge of engineering at the Lofstrand Co. His duties will involve contact with commercial, industrial and governmental sources.

ALLIED CHEMICAL CORP.'s Solvay Process division has appointed **Solon D. Fisher** assistant manager of the St. Louis Sales branch. He has a B.S. degree in chemical engineering from Kansas State College then joined Solvay in 1948 as a salesman. Fisher is a member of AIChE, NACE and Salesmen's Association of the American Chemical Industry.

MINNEAPOLIS-HONEYWELL REGULATOR CO. has appointed **Charles W. Wilkins III** market manager for laboratory and test instrumentation, Brown Instruments division. He joined Honeywell in 1955 as an application engineer, having formerly been instrumentation test engineer for Pratt & Whitney. Wilkins graduated from the University of Delaware in electrical engineering.

CROSBY VALVE AND GAGE CO. has elected **Jere J. Bresnahan** vice president in charge of sales. He joined Crosby in 1916 and has been manager of safety-relief valve and pressure indicating gage sales since 1941.

ALLIED CHEMICAL CORP.'s Solvay Process division has appointed **Harry C. Todd** manager of distributor sales. He will direct distributors throughout the nation. Named to succeed him as advertising manager is **William J. Cannon.** With Solvay since 1927, Todd spent several years in calcium chloride sales work until his appointment in 1946 as manager of advertising and sales promotion.

THE AMERICAN METER CO. reported that its subsidiary, Buffalo Niagara Industrial Controls, Inc., has purchased Buffalo Meter Co. of Buffalo, N. Y. **W. G. Hamilton, Jr.,** president of American Meter, will be president of the new subsidiary.

PUFFER-SWEIVEN CO., Southern Texas sales representative for Fisher Governor Co., has added a sales office in Beaumont, with **Joe Meek** in charge. Meek has instrument selection and sales experience in the Texas oil producing area and has been with Puffer-Sweiven two years.

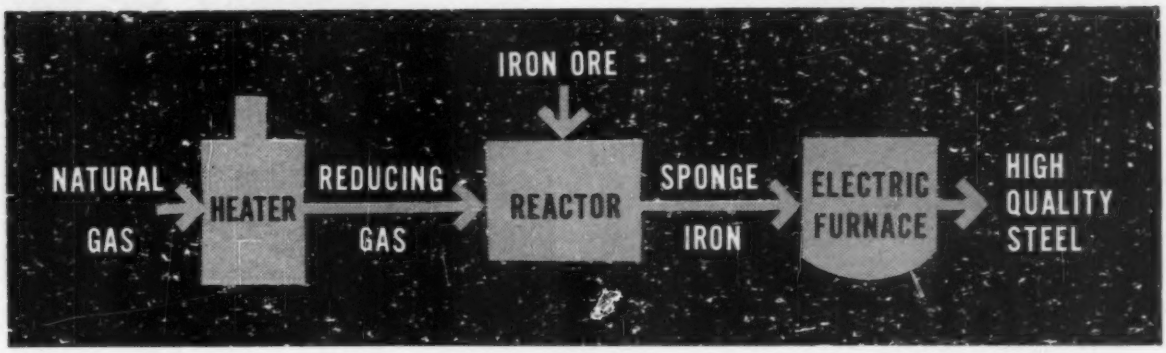
ALLIED CHEMICAL CORP.'s Solvay Process division has appointed **Arthur Phillips, Jr.,** vice president. Also named to new posts were: **Verne W. Aubel, Jr.,** to director of sales; **Robert L. Reynolds,** assistant director of sales, and **G. Richard Barclay,** manager of the Sales department's Organic Chemicals section.

GOODRICH-GULF CHEMICALS, INC. has appointed **Glen E. Wilson** director of employe and public relations. Until now, director of employe relations with the firm, he joined Goodrich-Gulf in May, 1956. Before this he had been with The B. F. Goodrich Co. since 1928 in a variety of responsibilities.

U. S. STEEL CORP.'s Oil Well Supply division has named **Herman L. Temple** field representative at Pettus, Texas. He joined the division in 1956 at McAllen, Texas, and was transferred in March 1958 to Alice.

BROADER MARKETS

for Petroleum or Natural Gas with New Sponge Iron Process available through M. W. Kellogg



A steel industry based on iron ore and petroleum or natural gas is economically and operationally practical using a direct reduction process available through The M. W. Kellogg Company, exclusive world-wide sales and licensing agent. The process yields a sponge iron which can be substituted for the pig iron or scrap charge to electric or other melting furnace.

The success of the sponge iron process has been firmly established in a 30 ton per day pilot plant and a 200 T/D production plant operated by Fierro Esponja S.A., an affiliate of Hojalata y Lamina S.A.—one of Mexico's principal steel producers. Based on the success of the present plant, HyL has awarded Kellogg a contract to engineer and construct a 500 T/D plant incorporating further improvements in thermal efficiency and materials handling.

Reduction of ore to sponge iron occurs in a controlled-atmosphere reactor. Neither coal nor limestone is required. Small, low-investment plants can be designed to meet practically any need and can be constructed at far below the cost of a blast furnace. The process was developed by Hojalata y Lamina—parent company of Fierro Esponja. The problems of economically obtaining a reducing agent from natural gas or petroleum, and of engineering and constructing the 200 T/D plant, were solved by Kellogg on the basis of its extensive experience in furnace engineering and hydrocarbon processing.

This is another contribution by The M. W. Kellogg Company to oil technology which promises an increased use of natural gas or petroleum throughout the world. Its wide experience in engineering and constructing refineries and petrochemical plants qualifies Kellogg to design and build plants for the sponge iron process.

For those desiring further information, a booklet explaining the sponge iron process in more detail is available. Arrangements for screening a motion picture showing the sponge iron process in action may also be made by writing The M. W. Kellogg Company.

M KELLOGG W

THE M. W. KELLOGG COMPANY, 711 THIRD AVENUE, NEW YORK 17, N. Y.

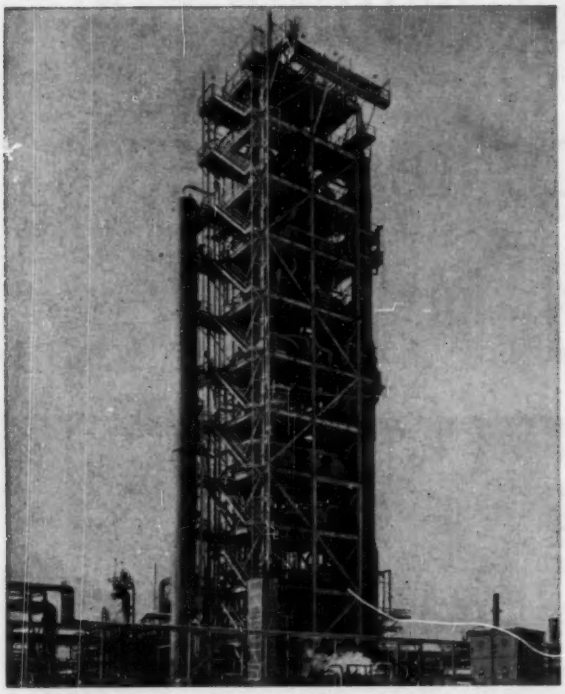
A SUBSIDIARY OF PULLMAN INCORPORATED

The Canadian Kellogg Co., Ltd., Toronto • Kellogg International Corp., London • Kellogg Pan American Corp., New York
Societe Kellogg, Paris • Companhia Kellogg Brasileira, Rio de Janeiro • Compania Kellogg de Venezuela, Caracas

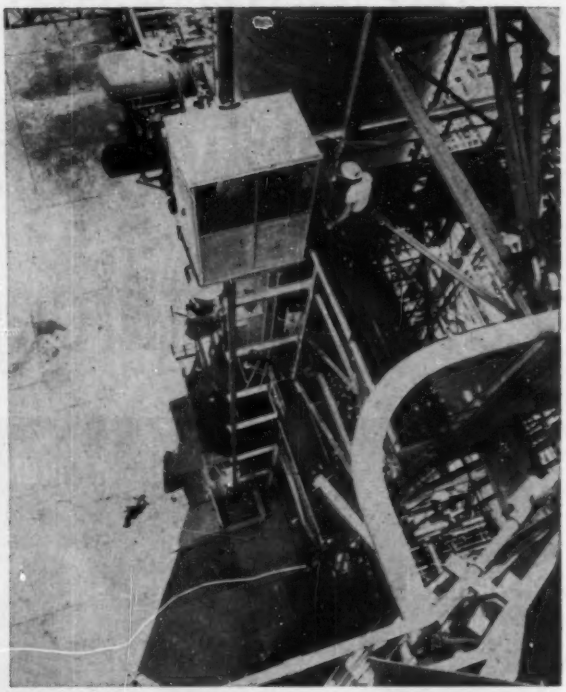
For more data on advertised products, use Readers' Service Cards, last page.

What's New in Equipment . . .

. . . and Manufacturers Literature



Old type "stairway" system fatigues workers, wastes time.



Portable Unit will pay off over the years in man-hours gained.

Portable Elevators Speed Turnaround

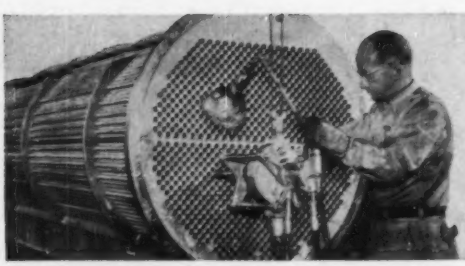
New unit is useful for hauling both materials and personnel, and is adaptable to common structures

Several major oil refineries have recently solved the problem of time lost in getting men to high work stations by using a new type demountable elevator approved for both personnel and materials transfer. In the past, the use of demountable hoists has been limited to materials handling only, thus restricting their application and cost-saving potential.

The refinery structure in the left photo clearly pictures the old way and new. Eleven flights of stairs on the left side of the unit trace the long, tiring climb to the summit. A vertical monorail near the unit enables the car to deliver eight men and their equipment to the top in three minutes. The first two floors of the elevator are caged to fend off mobile ground equipment. Safety is assured by use of two hoisting cables having a safety factor of thirteen times the rated load. If either cable should break—or even stretch—an emergency safety device would automatically clamp and lock the car to the column before it could fall one quarter-inch. Even if normal speed were exceeded a governor would automatically bring the unit to an instant stop. Motor, switches, and all electrical equipment are explosion proof.

The initial cost of installing *permanent* elevators at every site where periodic maintenance or service is required would be enormous—especially in instances where service may be extensive but infrequent, as in the case of cat cracker turnarounds, for example. A single portable elevator that can be transported between a number of process units, as required, is the most practical and economical solution to the problem.

The new type elevator travels on a vertical monorail made up of ordinary "H" beam sections joined to form a rigid column of any desired height. It is adaptable to various structures common in the petroleum industry. A Texas refinery reports using such an elevator as a permanent installation to serve five landings on a fluid catalytic cracker, requiring a total lift of 110 feet. In a Louisiana application, twelve landings of a structure are serviced. The total lift is 204 feet, and both operating and maintenance personnel use the elevator around the clock during turnaround and start-up periods. Even during regular production, at least 12 trips a day are made by operating personnel. At a Pennsylvania refinery this type of elevator is used to serve a number of case structures during annual shutdowns. Permanent "H" beam columns are erected alongside each case structure so that the same car



CONDENSER AND HEAT EXCHANGER CLINIC

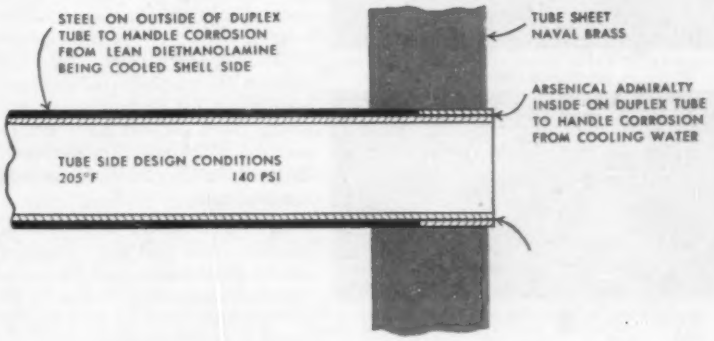
Edited by David S. Hibbard, Metallurgical Engineer
The American Brass Company, Buffalo 5, N. Y.

Duplex tube applications increase as corrosion and temperature-pressure problems grow more complex

New and improved processes in the chemical and petroleum industries—advancing design in power equipment both ashore and afloat, involving ever higher temperatures and pressures—are calling for more and more duplex tubes.

Working closely with both users and manufacturers of heat-exchange equipment, The American Brass Company is expanding its facilities to provide these special-purpose tubes in the combinations of metals and in the sizes and gages to meet new and growing needs.

Dual corrosion problems. Anaconda Duplex Tubes have been most often used to meet situations involving dual problems of corrosion. They are made by drawing tubes of copper or a copper alloy either inside or outside of steel tubes. However, they can be furnished in any combination of metals, including copper or copper alloys with other nonferrous metals or steel in a wide range of diameters and wall thicknesses.

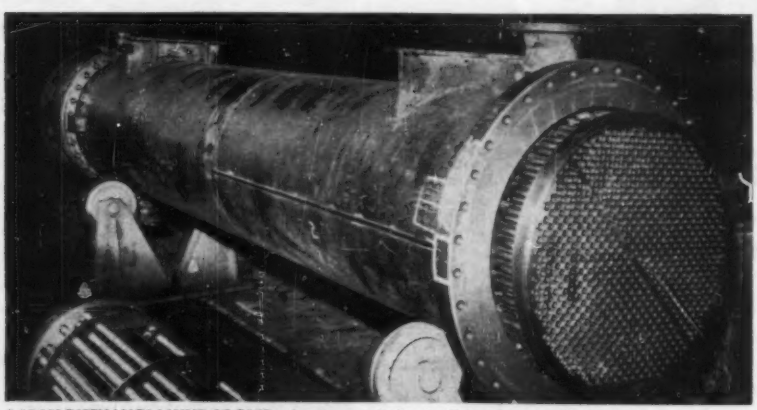

STEEL ON OUTSIDE OF DUPLEX TUBE TO HANDLE CORROSION FROM LEAN DIETHANOLAMINE BEING COOLED SHELL SIDE
TUBE SHEET NAVAL BRASS
ARSENICAL ADMIRALTY INSIDE ON DUPLEX TUBE TO HANDLE CORROSION FROM COOLING WATER
TUBE SIDE DESIGN CONDITIONS
205°F 140 PSI

SKETCH SHOWING CONSTRUCTION of Anaconda Duplex Tubes used in the cooler designed and built by Yuba. Tubes are ¾" O.D. x .065" wall x 16'1⅛" long. The 1⅜" thick tube sheets of Anaconda Naval Brass are 31⅝" in diameter and 35⅞" in diameter.

For extra strength. More and more Anaconda Duplex Tubes are being used in those applications where internal or external pressures—or the pressure temperature combinations—are too great for a nonferrous tube alone. In this case the nonferrous tube is selected for the chemical properties required for the more corrosive fluid handled; and the steel tube gives the needed strength.

U-bends. Duplex tubes can be readily bent to form the hairpin or U-bend tubes required for the compact U-bend tube design so advantageous in heat exchangers where wide temperature differences exist in the unit.

Technical Assistance. Specialists at the American Brass Company are constantly working with manufacturers and users of heat-exchange equipment, helping to solve process problems. This experience is available to you. For more detailed information on Duplex Tubes, U-bend Tubes, address: The American Brass Company, Buffalo Division, Buffalo 5, New York. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 5879



A LEAN DIETHANOLAMINE COOLER using Anaconda Duplex Tubes (see detail sketch above) designed and built by Yuba Heat Transfer Division of Yuba Consolidated Industries, Inc., Honesdale, Pa. This unit will cool Lean Diethanolamine at the new 19,000 barrels per stream day delayed coker designed, engineered and being constructed for Socony Mobil at Paulsboro, N. J. by The Lummus Company.

ANACONDA®
TUBES and PLATES for CONDENSERS & HEAT EXCHANGERS
Made by
THE AMERICAN BRASS COMPANY

For more data on advertised products, use Readers' Service Cards, last page.

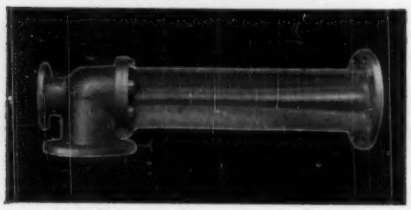
Simplify handling of

fluids, vapors, gases . . .

and "HOT" MATERIALS

Series IA and 20A Ejectors perform efficiently over a wide range of operating conditions.

Series 60A fluid operated jet pump for lifting, elevating and blending liquids or slurries.



Special jet pump for handling corrosive chemicals. Stainless steel with flanged connections.

Low-cost, compact Penberthy ejectors provide many unique dependable services in AEC operations, chemical and petroleum processing, power, water and sewage handling and many other industries.

Through long specialized experience, Penberthy has successfully adapted the simple jet principle to a variety of applications. Penberthy ejectors are now incorporated into numerous OEM products; are being used increasingly where mechanical pumps simply cannot be used or are at an economic disadvantage.

They are available in standard, modified and specially designed models from a variety of materials. Worth investigating, Penberthy jet pumps are detailed in Catalog 512R — sent on request.

PENBERTHY
MANUFACTURING COMPANY
Division of the Buffalo-Eclipse Corporation
1242 Holden Avenue, Department R
Detroit 2, Michigan

Series 60P corrosion-resisting Uscolite plastic hydraulic ejector. Rigid. Tough. Lightweight.

Special stainless steel where corrosion resistance and/or non-contamination are required.

PENBERTHY EJECTORS

STEAM, AIR & LIQUID OPERATED FOR:

Liquid Transfer, Heating, Circulating, Aerating, Agitating, Mixing, Pumping, Blending and Exhausting Air or Vapor against High Vacuum.

There's Certain Satisfaction in **PENBERTHY Cycling Jet Pumps • Ejectors Injectors • Electric Sump Pumps**

New Equipment . . .

and power unit can be moved from one column to another. Only a few hours are needed to detach the elevator from a column at one location and remount it at another.

In the right photo, ordinary H-beam sections project from 15 foot intervals to serve as stabilizer connectors for the mounted column. The car and power unit can be moved to other locations for turnaround service. This car is 4 x 6 x 7 feet. Ground-level gates are at one end and landing gates at the other. Travel speed here is 55 feet per minute.

There are three general types of application for these elevators. First is its use as a packaged transportable unit—complete with car, power drive assembly, and H-beam sections—for temporary installation at different locations. In these cases the column is erected, the car operated until completion of the project, column and all again demounted, and the entire "package" transported to another work site.

The second type of application is that described above—"turnaround." For this purpose several columns are erected permanently adjacent to different structures, so that only the car and power unit need be moved around among a number of fixed locations.

The third kind of use is permanent installation on a new existing structure. Installed at the beginning of new construction, this provides a two-fold benefit. The elevator first pays for itself during the building phase by hauling workmen and tools as construction progresses, and is then left at the same site permanently the routine maintenance and operating use.

Labor savings are clearly illustrated by citing the case of a northeastern refinery. For years 150 to 200 men had climbed stairs to heights of 150 feet during shutdowns of the company's case structures and other high units. During these periods, there was continual up-and-down travel of personnel to obtain tools, etc., and periodic visits had to be made by foremen and technicians. Because of the exorbitant amount of r hours involved, a demountable elevato as finally purchased which now services units in rotation during shutdowns. It is used from two to three months at each location. Instead of the time-consuming drudgery of climbing hundreds of stairs, resting en route, and taking required rests after reaching the work level, the men are now transported up and down—as many as eight at a time—in minutes. No rest periods, no fatigue.

Humanitarian interest, assuring employee safety and health, has also given impetus to the search for a solution to this problem. The demountable elevators now available have been specifically designed to solve these problems and are finding wide acceptance in the industry. Hawkeye Products Corp.

Circle E1 green card, last page

Mechanical Seal Operates Without Lubrication

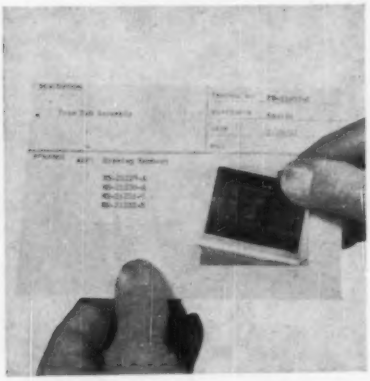
A new, high-performance mechanical seal that will operate without lubrication has now been perfected. The new, dry-running seal, known by its R&D code designation of Spec. PS-113 operates with two specially treated carbon faces running against each other.

Spec. PS-113 yields a minimum in heat development and friction and gives com-

patibility found in no other face material combinations.

Field tests to date have shown the new dry-running seal will perform satisfactorily under the following conditions; pressure at 150 psi, temperatures to 600 F., rubbing speeds to 12,000 fpm with lubrication being intermittent or none at all. Sealol Corp.

Circle E2 green card, last page



Microfilm Holder Makes Filing of Documents Easy

Snap-Jacks, a new device for mounting individual microfilm images in a filing card, has just been announced.

Snap-Jacks makes it possible to remove a specific filmed document from a roll of film, insert it quickly into the Snap-Jack pocket which in turn snaps into any type of filing card with a pre-cut aperture. It is designed for any situation where the document itself must be an integral part of a card which contains additional information—engineering drawings, deeds, mortgages, manufacturing specifications, etc.

The Snap-Jack itself is a transparent tri-acetate holder into which the film is inserted, accommodating an image of 16 mm, 35 mm or 70 mm film. Top and bottom edges consist of two facing pieces of tri-acetate. These are snapped into place on the top and bottom edges of an aperture in the card. The remaining area of the card provides space for data.

The holes for the aperture are positioned either at the right or left side of the card, so that successive cards may be filed with the filmed images in alternating positions to eliminate excessive build-up on one side in the file. They can be indexed in any known indexing procedure, and filed in standard housing for vertical cards. The snap jack card is easily slipped in a Kard-A-Film reader for reference. Remington Rand Division of Sperry Rand Corp.

Circle E3 green card, last page

Bulletin Describes Punch Card Process Control

Punch card process control for batch or continuous flow system is covered in the new Bulletin J 200. This condensed two page bulletin describes a low cost punch card formula control system for volumetric or gravimetric systems. It is designed to be added to existing plant systems to convert from manual to remote or automatic control. The bulletin also describes the application of the punch card components to machine tool positioning and programming. The Jordan Co., Inc.

Circle E4 green card, last page

Bulletin Covers Low Cost Stainless Heat Exchangers

A new, illustrated bulletin just issued by Ross Heat Exchanger division, presents Ross Type SSCF stainless steel exchangers for production and pilot plant applications of the chemical and process industries.

Described as fully standardized and mass-produced for low cost, this series features the same design and compact dimensions as the Ross Type BCF Exchanger which has a copper-alloy core assembly.

Included in the bulletin are details on important features designed to assure maximum heat transfer, plus specifications on the 19 models available in one-, two-, and four-pass designs. American-Standard.

Circle E5 green card, last page

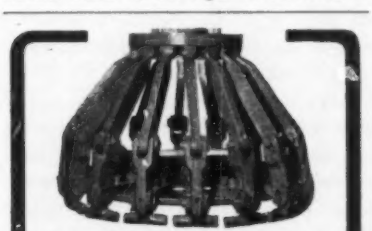
Adhesives Bond Teflon With High Peel Strength

Two new adhesives for cementing bondable Teflon to itself or to other materials have been announced. The first, Ray-Bond R-86009, is recommended for applications where some flexibility in the bond is required. It has good resistance to water and most chemicals. The other, Ray-Bond R-86044, features excellent resistance to acids (except acetic), water and various other chemicals.

Both materials are two-component (base and activator) systems which will bond etched Teflon to wood, steel, glass, aluminum, ceramics, plastics or any other material that will bond with an adhesive. They may be cured at room temperature or at elevated temperatures.

Ray-Bond R-86009 can be used as a structural adhesive at temperatures up to 120 F. or as a non-structural adhesive up to 250 F. The temperature limitations for Ray-Bond R-86044 are 200 F. for structural use and 250 F. for non-structural use.

The structural tests were made by bonding a one-inch wide strip of Teflon to sandblasted steel, placing the assembly in a vertical position and pulling the Teflon at an angle of 180 degrees with a five-pound load for 48 hours at various temperatures. The non-structural tests were conducted in the same manner except that the adhesive was required to support only the weight of the Teflon. The maximum



BARRETT automatic

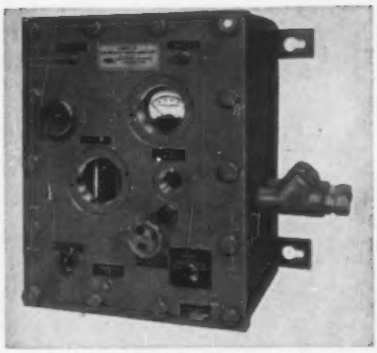
Filling and Crimping Equipment

for handling greases and other viscous fluids.

- No operator required.
- 100% air operated.

Fills, seals, stamps and counts lug cover pails. Output of 15 pails per minute. Write for details on installation to meet your requirements.

BARRETT
Manufacturing Co.
P. O. Box 8096, Houston 4, Texas



Model W Electrolytic Moisture Analyzer
Explosion-Proof Model

Measures water content better than 1 part per 1,000,000!

Some Useful Applications:

- Continuous or batch analyses of water in a wide variety of gas and liquid streams—including process streams, inert atmospheres required in plant processes and laboratory dry boxes, and plant instrument streams.
- Measuring reaction rates where water is involved as a reactant, product, or catalyst.
- Studies of moisture permeability of polymers.

Write for complete information

MANUFACTURERS ENGINEERING & EQUIPMENT CORP.
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Makes Higher Heat Resistant Concrete

Haydite aggregate used with Lumnite cement produces refractory concrete suitable for sustained temperatures up to 1800-2000° F., which makes it excellent for tubular heaters, ducts, flues, stacks and catalytic crackers. Weighing from 30 to 40 per cent less than ordinary aggregate concrete, Haydite is exceedingly strong. It has excellent insulating properties and withstands pressures of up to 1130 pounds per square inch. Write today for free folder and complete information about Carter-Waters Refractory Haydite.
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Dependable

SACHSE ELECTRIC
INC.
BATON ROUGE LA.

For more data on advertised products, use Readers' Service Cards, last page.

These synthetic detergent storage tanks resist corrosion because they're made from Stainless Steel, USS 18-8, Type 304.

To safely store synthetic detergents, we turned to Stainless Steel

"We make synthetic detergent that is mildly corrosive to conventional metal tanks," says Mr. L. R. Henry, Maintenance Engineer at the Atlantic Refining Company "Ultrawet" Plant in Philadelphia. "We have tried other metals and sprayed-on coatings. In our experience, Stainless Steel tanks have given the best protection yet against corrosion and product color deterioration. We've had these Stainless tanks for more than four years without any corrosion problems. We expect them to last about three times as long as conventional tanks."

If corrosion has cut short the service life of your equipment, replace it with Stainless Steel. In the long run, it costs a lot less because Stainless Steel lasts a lot longer. And if you want to be positive of service-tested quality, specify USS Stainless Steel.

USS is a registered trademark

United States Steel Corporation—Pittsburgh
American Steel & Wire—Cleveland
National Tube—Pittsburgh
Columbia-Geneva Steel—San Francisco
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Supply—Steel Service Centers
United States Steel Export Company

USS United States Steel

temperatures noted are those at which there was no sign of peeling at the end of the 48-hour test.

The adhesives are prepared for application by mixing the base and activator in specified amounts. The pot life (length of time during which the mixture is fluid enough to work) for Ray-Bond R-86044 is 40 minutes for 100-gram batches and 20 minutes for 600-gram batches. The pot life can be extended by cooling the blend in a shallow tray kept immersed in water at a temperature of 60 to 65 F. Handled in this way, the pot life of 100-gram batches is one hour and that of 600-gram batches is 40 minutes.

The pot life for Ray-Bond R-86009 is two hours. Cooling is not necessary. Raybetos-Manhattan, Inc.

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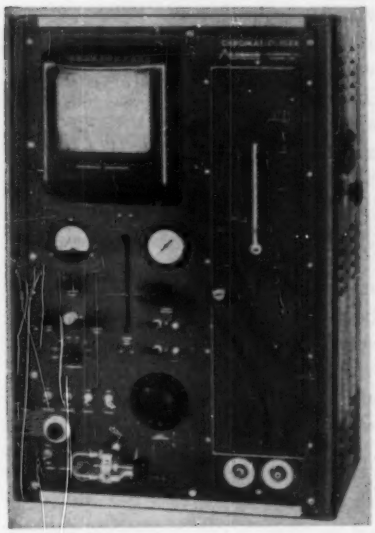

Gas Chromatograph Has Unusual Flexibility

The Model 1A Chromat-O-Flex gas chromatograph provides unusual flexibility at a moderate price. Optional features include proportional electronic temperature control, column reverse switching, dual column switching with automatic backflush, series column switching, reproducible volume gas sample valve, and regulated power supply. Temperature range is from ambient to 225 C. Oven design permits the use of a Dewar flask within the oven for sub-ambient column operation. Detector design and circuitry permit the use of either high sensitivity filament elements or ultra-sensitive thermistor elements. Several instruments may be connected in series for staged operation with simple connection tubes. The dual column switching automatic backflush option greatly increases analysis speed and permits quite different analyses to be run without changing columns. Loe Engineering Co.

Circle E7 green card, last page

Computer Case Histories Described in Booklet

A new booklet describes a number of proven engineering programs for refineries using the 650 computer. It covers the program used on plate-to-plate distillation

assures precision metering !

CHEMICAL FEEDERS by Manzel give accurate, dependable metering of chemicals, acids, oils, and many other liquids. Rugged, trouble-free units are available in large or small capacities, with single or multi feeds, for any type of drive. Delivery from one cc/min/feed to one gal/min/feed, against pressures to 5000 psi. Consult your Manzel field engineer for full details and recommendations.

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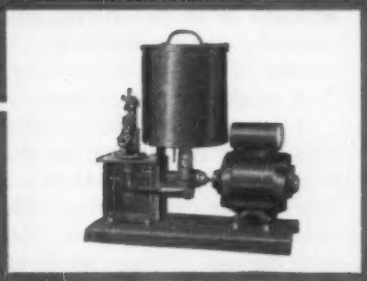

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Specialists in metering pumps and lubricators since 1898

SPECIFICATION: Alcoa Aluminum

CHARACTERISTICS: low cost • minimum metal pick-up • short half life • special resistance to CO_2 • no color imparted • nontoxic • contributes no iron or copper contamination

High purity water itself represents an appreciable investment. Protection of that investment requires a special combination of characteristics in the metal used to contain high purity water. Aluminum provides those properties at a cost far lower than that of other metals which might be used. That's why more and more ALCOA® Aluminum is being specified today for handling high purity water in such varied applications as these: reactor cooling systems in nuclear power plants . . . condensate handling in both nuclear and orthodox power generation systems . . . pharmaceutical manufacturing . . . television picture tube manufacturing . . . and a variety of laboratory systems where high purity water must be stored or circulated.

The outstanding corrosion resistance of aluminum insures minimum metal pick-up—important to maintaining water purity at the highest possible level. Aluminum's special resistance to CO_2 makes it ideal for storing or handling boiler condensate. It imparts no color to the water it contains. It is nontoxic. And aluminum's short half-life makes it an ideal material for atomic reactor applications (see flow chart).

In addition to all this, aluminum combines light weight with great strength in alloys. It has excellent thermal conductivity . . . is nonmagnetic and nonsparking . . . is highly workable and lends itself to a variety of welding or brazing techniques for sound, easy fabrication. And, again, aluminum provides all these assets at the lowest cost.

If you work with high purity water, it will pay you to discover more about the ways you can use aluminum to make your systems work best, most economically. ALCOA's development engineers have had many years' experience working with aluminum in nearly every type of high purity water storage and distribution system. Their experience is at your disposal. Simply write Alcoa, describing the requirements of your system, in order to receive all available technical data and performance information. Address ALUMINUM COMPANY OF AMERICA, 905-M Alcoa Building, Pittsburgh 19, Pennsylvania.

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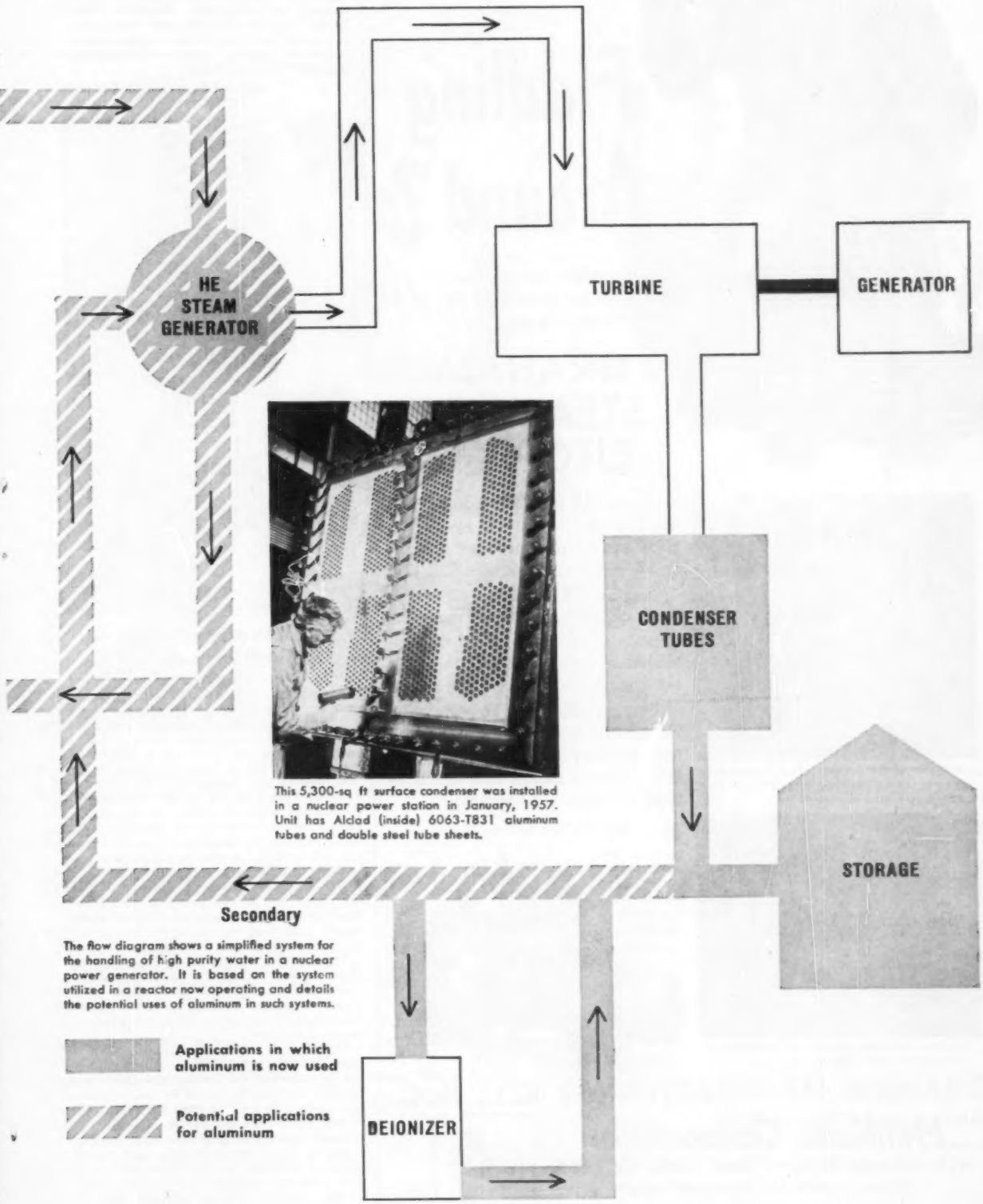
SEND FOR THIS FREE LITERATURE. Alcoa will be happy to send you this comprehensive set of literature related to the use of aluminum in high purity water systems. Included are several papers from Conferences of the National Association of Corrosion Engineers, a five-year service report on an aluminum condenser tube installation and other technical data. You can obtain this data promptly by writing Alcoa at the address given above.

for high purity water systems



This 5,300-sq ft surface condenser was installed in a nuclear power station in January, 1957. Unit has Alclad (inside) 6063-T831 aluminum tubes and double steel tube sheets.

Secondary

The flow diagram shows a simplified system for the handling of high purity water in a nuclear power generator. It is based on the system utilized in a reactor now operating and details the potential uses of aluminum in such systems.

Applications in which aluminum is now used

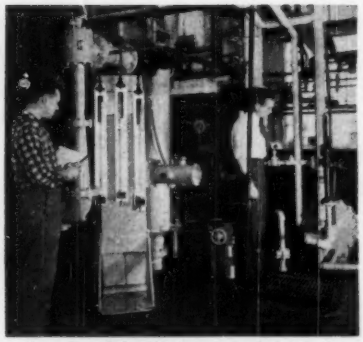
Potential applications for aluminum

For more data on advertised products, use Readers' Service Cards, last page.

Fiddling Around?

Unfortunately many of us do just that—but on your next job, at no greater cost, you may use

GRAHAM STEAM JET EJECTORS



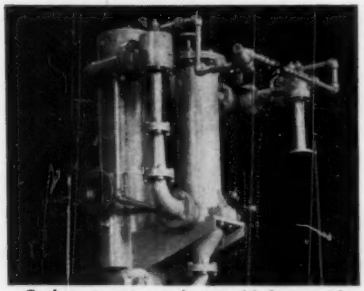
A corner of the Graham vacuum laboratory where current designs are tested under actual operating conditions

and you will certainly not be "fiddling around". You will be using a tried and proven product that involves no guesswork.

Graham Steam Jet Ejectors have served industry for over *one quarter of a century* and our installation list reads like the blue book of America.

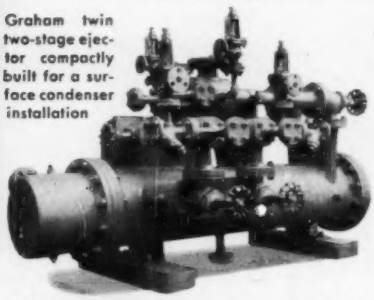
Graham Research at Batavia, New York is constantly exploring new features that insure you the most modern design and performance in vacuum equipment.

Write for our Bulletin 70-A



Graham two-stage ejector with barometric inter-condenser in distillation service

Graham twin two-stage ejector compactly built for a surface condenser installation



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New Equipment . . .

calculations, distillation tower design by shortcut methods, linear programming, a regression analysis program, heat exchanger calculations, Benedict, Webb, Rubin equation of state, pipe stress analysis system, and the process engineering interpretive coding system. International Business Machines Corp.

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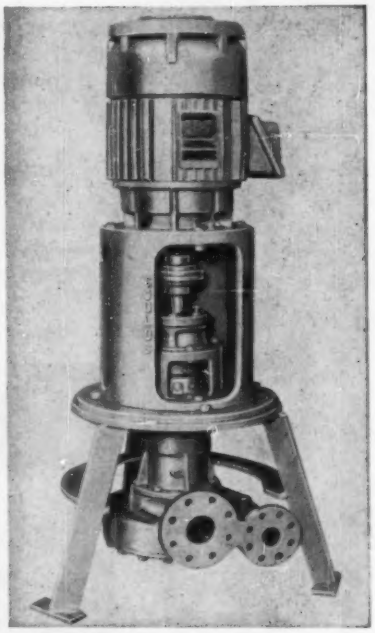
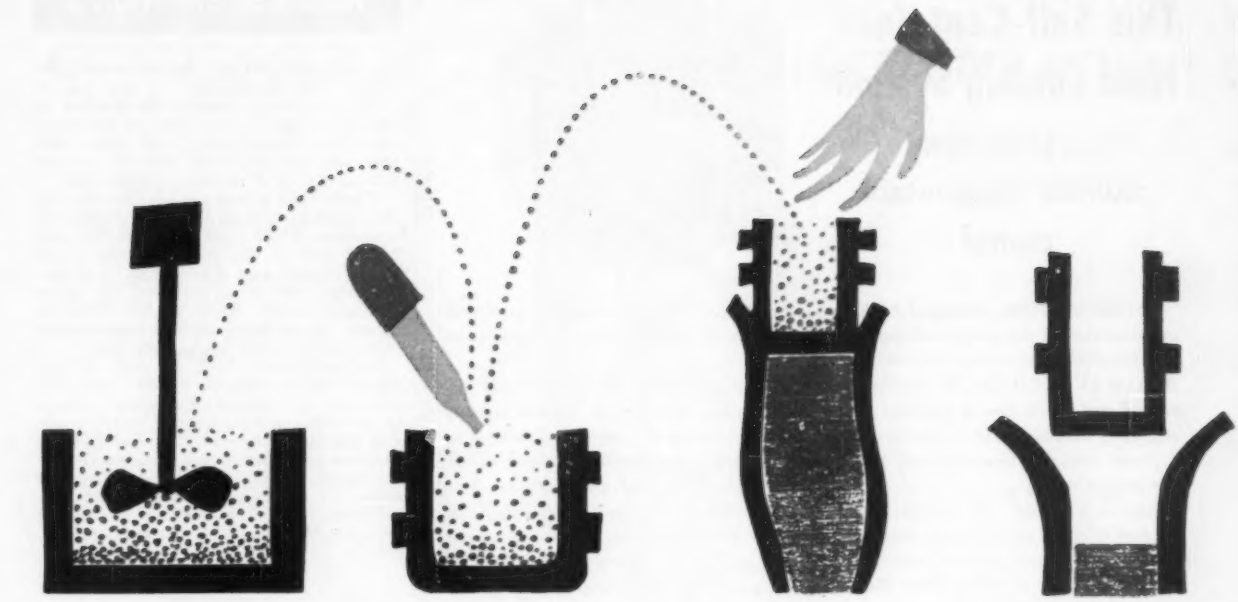


Vertical Process Pumps For Difficult Liquids

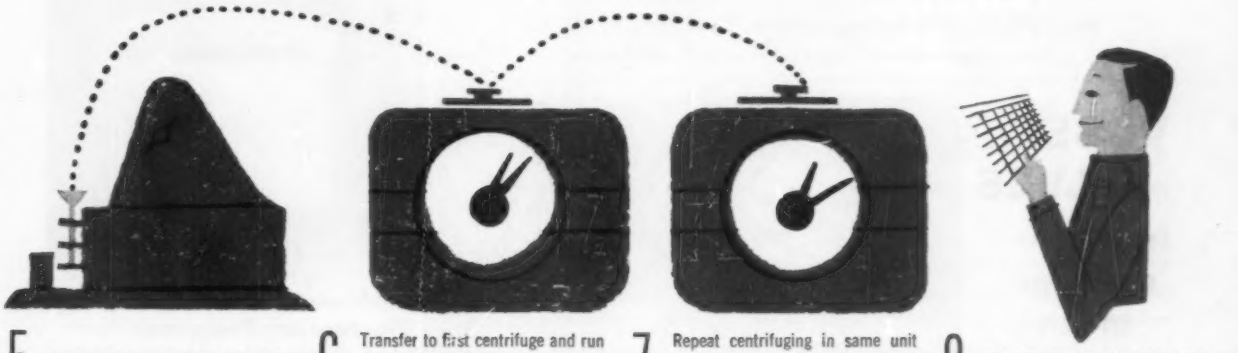
Tripod mounted vertical centrifugal process pumps with stainless steel or other corrosive resistant metal liquid end or with a glassed pump liquid end have just been announced. With stainless steel or other resistant metal end, the pump is designated Figure 3181 and is designed primarily for two special and unusually difficult services; the handling of highly volatile, inflammable, toxic, explosive, or other dangerous liquids where it is necessary that the pumpage be completely isolated from the atmosphere; or pumping liquids at extremely low or high temperatures (—320 F. to +550 F.) where it is essential that the liquid end of the pump be well insulated from the bearings, mechanical seals, driver and free to contract or expand without binding and distortion.

Figure 3182 vertical process pumps with glassed pump liquid end are designed for use where the liquid to be handled is of highly corrosive nature or where nonadherence of product or no metal contamination is required.

Figure 3181 units are designed with a closed adapter and column which allows the introduction of pressurized inert gas or clear compatible liquid to isolate bearings and upper stuffing from the pumpage. Proper control of gas or liquid positively prevents contact of pumpage with outside elements. The carbon bearing and casing bushing, suitable for dry operation, are thus protected against abrasive pumpage. Carbon casing bushings restricts flow of



1. Prepare suspension of particles.
2. Transfer suspension to feeding chamber.
3. Transfer feeding chamber to centrifuge tube.
4. Remove feeding chamber, leaving sharp layer of suspension on top of sedimentation liquid.



5. Read sediment height under gravity in projector at precalculated times.
6. Transfer to first centrifuge and run for precalculated time, then remove and read in projector.
7. Repeat centrifuging in same unit or in higher speed centrifuges until run is complete.
8. Size distribution is obtained from sediment height data.

New Low-Cost Way to Measure Size Distribution of Small Particles

With the new M-S-A® Particle Size Analyzer, you can start with a minimum investment for measuring particle distribution, and then expand it by the purchase of additional components.

This versatile analyzer is a general-purpose device for measuring size distribution of small particles. It is especially designed for measurement of subsieve particles between approximately 0.1 and 40 microns. Most airborne dusts, paint pigments, and many flours, chemicals, and pharmaceuticals lie within this range.

Complete analyzer system includes centrifuge tubes, feeding chamber, optical tube projector, one or more special centrifuges, and tube handling and cleaning accessories. Write for new bulletin for details.

Tube Projector

Centrifuges

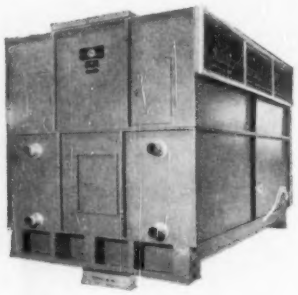
MSA

INSTRUMENT DIVISION
Mine Safety Appliances Company
Pittsburgh 8, Pennsylvania

For more data on advertised products, use Readers' Service Cards, last page.

This Self-Contained Fluid Cooling System

... gives most accurate temperature control



Applied in cooling industrial machines or processes to temperatures approaching the ambient wet-bulb, the NIAGARA *Aero* HEAT EXCHANGER is independent of any more than a nominal water supply or disposal. The coolant system is a closed one, free from dirt and maintenance troubles.

Heat is removed from your process *at the rate of input*, giving you precisely the temperature you require and assuring the quality of your product. Heat may be added to prevent freezing in winter or for better control in a warm-up period. Liquids or gases are cooled with equal effectiveness.

Heat is rejected outdoors. Only the little water evaporated on the cooling coils in the air stream, or discharged to prevent hardness build-up, is consumed.

Niagara sectional construction saves you much installation and upkeep expense, gives full access to all interior parts and piping. Your equipment always gives you full capacity and "new plant" efficiency.

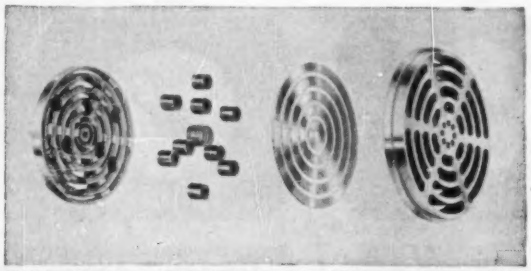
Write for Niagara Bulletin No. 132 for complete information

NIAGARA BLOWER COMPANY

Dept. PR-12, 405 Lexington Ave., New York 17, N. Y.

District Engineers in Principal Cities of U. S. and Canada

VOSS VALVES in your machine mean



LESS MAINTENANCE, FEWER SHUTDOWNS for your compressor. (air, gas, ammonia)

- up to 40% more valve area • minimum pressure loss • higher efficiency
- less power consumption • normal discharge temperature
- quiet, vibration-free • utmost safety • lower operating costs

VOSS VALVES are made to specification, machined from solid stock (not cast) — VALVES and PLATES are of heat-treated alloy or stainless steel; PLATES are machined, not stamped, and ground for precise close-tolerance fit; are dimensionally stable ... ductile ... resist fracture, high temperatures and corrosion ... withstand fatigue. SPRINGS, of heavy rectangular sections and large diameters, add to dependability and safety.

Our detailed proposal will be sent without obligation. Send name, bore, stroke and speed of machine.

J. H. H. VOSS VALVES REG. U.S. PAT. OFF.

J. H. H. VOSS Co., Inc.
785 East 144th Street, New York 54, N. Y.

New Equipment...

gas or clear liquid into the pumpage. Controlling the temperature of the gas or liquid in column permits the bearing to operate at optimum temperature for maximum life. Casing design with pump suction and coupling side subjects column bearing and seal suction pressure only.

Figure 3181 pumps are available in nine sizes from ¾ inch to 3 inch discharge and capacities to 800 gpm, heads to 300 feet. Liquid end of the pump, including the closed adapter and column can be of carbon steel, 300 series stainless, 400 series stainless, Goulds Alloy 20, all iron, all bronze, bronze fitted, all iron with stainless steel trim or other machinable alloys.

In the Figure 3182 all parts of the pump which come in contact with the pumpage are glassed. The glass is fused to the metal to form a tough highly corrosion resistant material. These pumps offer excellent resistance to all acids except hydrochloric, even at elevated temperatures to 350 F. and to alkalis at moderate temperatures. Pumps give capacities to 700 gpm, heads up to 140 feet. Goulds Pumps, Inc.

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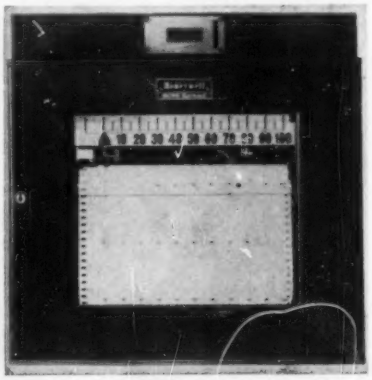


Instrument Records Rapidly Fluctuating Processes

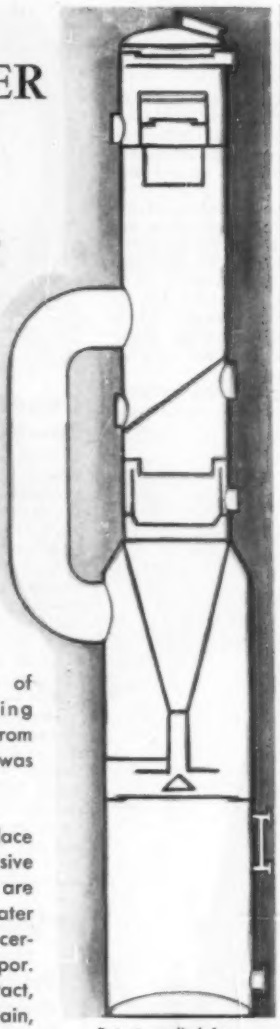
An electronic strip chart recorder with continuous integration has been developed for rapidly fluctuating industrial processes. It measures, records and continuously totalizes any linear variable with respect to time, the company said. Although designed primarily for gas chromotography analysis it can be used to measure flow or other variables.

The instrument reads out the integration quantitatively on a six-digit electric counter up to 1,000 counts per minute, or records the qualitative or analog equivalent on a chart graduated in units and tens by means of a dual pipping pen at a maximum rate of 500 strokes per minute. The readout can be adapted to digital or data-handling systems in special applications by substitution of a contact-making counter.

Full-scale travel of the recording pen requires two seconds, but the instrument is available with or without pipping pen. Available chart record speeds are 30, 60, 90 and 120 inches per hour. The recorder is made with a live zero, permitting overtravel below the zero line.

Accuracy of the integrator, which is equipped with a stroboscope for calibrating purposes, is plus or minus 0.5 percent. Com-

JET CONDENSER IS HEART OF NEW *Convactor*



Patent applied for

Our CONVACTOR was developed to solve a problem in the vegetable oil industry, but it seems that it has even more important applications in the petroleum industry. It was used first to recover fatty acids from the stripping steam from deodorizers. They are now recovered in purer and more valuable form than ever before. At the same time, pollution of surface water and cooling towers by the effluent from barometric condensers was completely eliminated.

A CONVACTOR would replace the large and very expensive surface condensers which are often used to prevent water pollution and to recover certain components of the vapor. It condenses by direct contact, but promptly flash cools again, and accumulates high boiling components and other impurities in a stream of recirculated water. The ratio of oil to water can be controlled over a wide range, facilitating oil recovery. The flashed vapor condenses in a conventional barometric condenser which discharges its water just as pure as when it entered.

CROLL-REYNOLDS

Manufacturers of Steam Jet Vacuum Equipment For Over 40 Years.

Croll-Reynolds CO., INC.

Main Office: 751 Central Avenue, Westfield, N. J.

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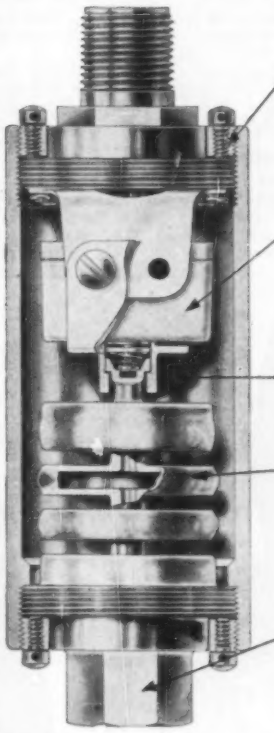
CHILL-VACTORS • STEAM-JET EVACTORS • AQUA-VACTORS • FUME SCRUBBERS • SPECIAL JET APPARATUS

NEW PRESSURE SWITCH FOR HIGHLY CORROSIVE MEDIA


Threaded (adjustable) Construction Shown; Welded construction optional
Snap action Switch
Overtravel protection
Welded multiple diaphragm sensing element —not to be confused with an accordion bellows.
¼" internal pipe thread pressure connector is standard—Welding fitting optional.

SAVE EXPENSE OF CHEMICAL PROTECTORS...OFTEN MORE THAN THE PRICE OF THE PRESSURE SWITCH

This new tier-tube line of Meletron pressure switches is available in materials suitable for use with concentrated hydrogen peroxide, fuming nitric acid, liquid oxygen, proprietary amine fuels, fluorine, mixtures of fluorine and liquid oxygen and others.

Proof pressures range from 224 to 6000 P.S.I., pressure settings from 2 to 4800 P.S.I. Switches will operate in temperatures from −65° to +275° F. Standard pressure port fitting is ¼" internal pipe thread but may be substituted by special welding fitting. The housing serves as a pressure tight safety capsule in case of a break in the sensing element. Single pole double throw switching elements are rated to 10 amps., for AC and DC circuits. Free leads or Cannon plug are optional for electrical connection. As an added safeguard, the stainless steel models will withstand 2000° heat for five minutes.

Write for bulletins 1110 to 1170.

PRESSURE SWITCH DIVISION

barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

For more data on advertised products, use Readers' Service Cards, last page.

New Equipment . . .

bined accuracy is plus or minus 1 percent or better.

The instrument can be actuated by any primary element, or transducer, which provides a linear d-c millivolt output within range limits. Brown Instrument division, Minneapolis-Honeywell Regulator Co.

Circle E10 green card, last page

Catalyst Support Pellets Have High Alumina Content

A new "Shamva" Mullite pellet made by a unique manufacturing process, has been developed. The exclusive process enables the manufacturer to produce and sell the ¼ inch to ⅞ inch "Shamva" pellets at prices very attractive to major oil refineries which use the catalytic reforming process. The pellets are used as inert supports for the active catalyst in fixed bed convertors.

The pellets are already approved for use by major oil companies. Their important properties are resistance to abrasion and heat shock, high density, high refractory value and low porosity. They do not dust or break.

Having a high alumina content of approximately 70 percent, the pellets are essentially chemically inert. Average physical properties are: PCE cone 39; apparent porosity 10.7 percent; bulk density 163.8 pounds per cubic foot; apparent specific gravity 2.94; and packed density 95 to 100 pounds per cubic foot. Average chemical analysis is available upon request. H. K. Porter Co., Inc.

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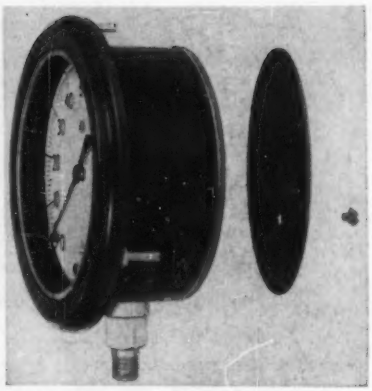
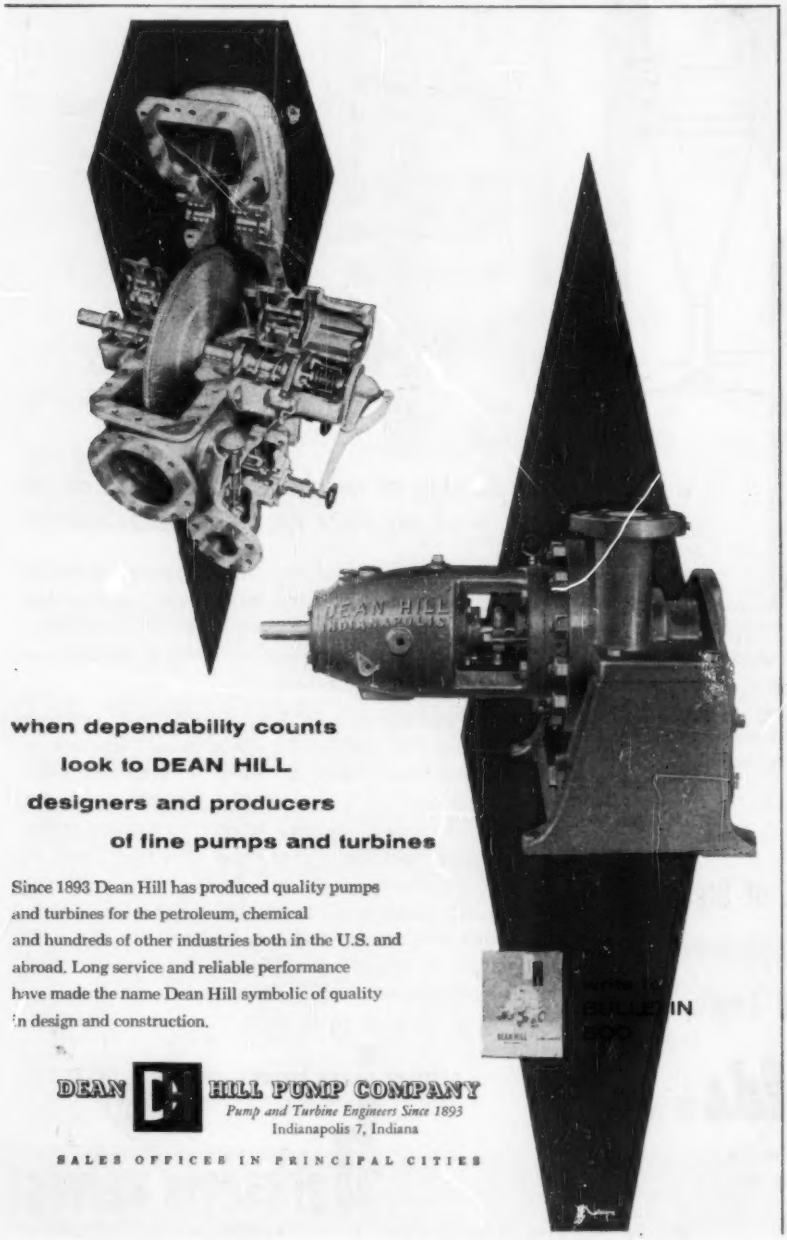


Gage Prevents Injury if Bourdon Tube Ruptures

Affording greater protection to the worker from Bourdon tube rupture due to overpressure, corrosion, or other factors, are features of a newly designed pressure gage with a solid and integrally cast metal front plate.

Departure from normal construction consists mainly of a solid metal front plate which forms a partition or protecting wall between the dial and the tube. This partition is designed to divert the force of a burst in a backward direction, away from the operator, where it is permitted to escape by deforming the back cover plate.

Designated as the Safe-T-Case Gage, its gasketed and deformable back plate covers the entire rear of the unit and can be forced open by a minimum pressure of 3 psi. For added safety in the event of a sudden high pressure surge, this back plate which is held in place by a threaded screw, will not detach itself from the gage. The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look to DEAN HILL
designers and producers
of fine pumps and turbines
Since 1893 Dean Hill has produced quality pumps and turbines for the petroleum, chemical and hundreds of other industries both in the U.S. and abroad. Long service and reliable performance have made the name Dean Hill symbolic of quality in design and construction.
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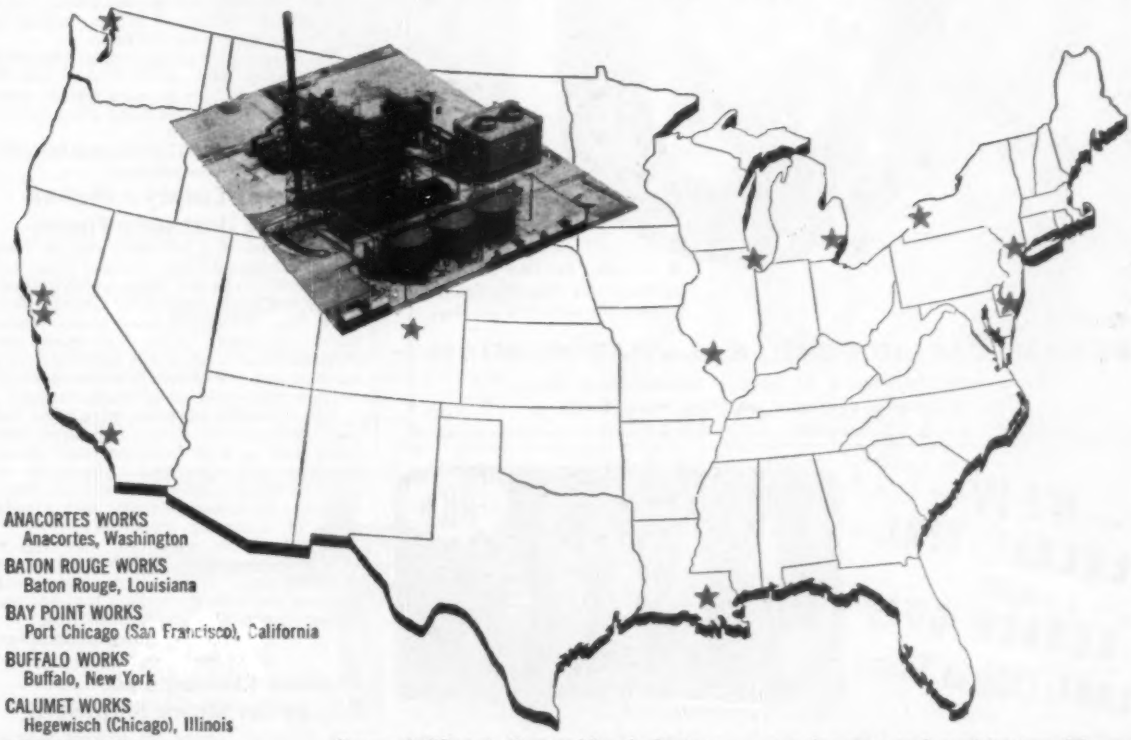
An important message ***to every sulfuric user interested in spent acid recovery...***

12 GENERAL CHEMICAL Plants

are equipped to handle spent acid for you



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General Chemical provides industry with sulfuric acid from 18 producing points, located in major centers of commerce from coast to coast. Of these, 12 are equipped to handle spent acid—providing unmatched experience, service and facilities to customers interested in spent acid recovery.

Relatively high strength, impure sulfuric presents many problems of handling and disposal. With General's help you may be able to turn this costly nuisance into an economic asset.

Whether we can help you or not depends on a number of factors: The acid strength . . . The nature and amounts of contaminants . . . The tonnage available . . . The distance of your location from our nearest plant. Generally, spent acids containing 70%-80% sulfuric acid, or higher, can be reclaimed if they do not contain impurities harmful to the equipment.

Our experience in solving spent acid problems of every kind is at your service. For further information, write or call your nearest General Chemical office.

Allied Chemical

GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N. Y.

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DURAMETALLIC *Packings*

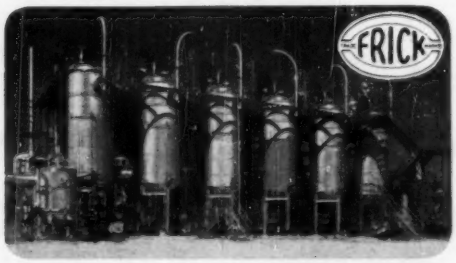
Write today for FILE No. PR describing the complete line of Durametallic wear-free packings.

Product of

DURAMETALLIC CORP., KALAMAZOO, MICH.

Also manufacturers of rotary mechanical seals, oil pressure systems and packing tools.

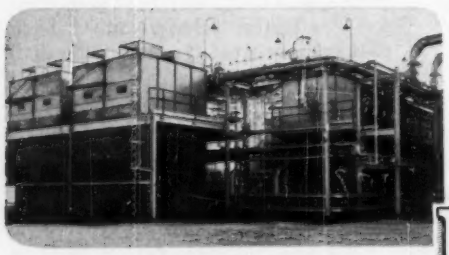
—NEW— GENERAL TIRE AND RUBBER CO. PLANT: Odessa, Texas



Frick Company furnished the twelve big reactors* illustrated, each 22 ft. high and equipped with a double set of Frick cooling coils*; plus coolers and evaporative condensers for butadiene, evaporative condensers for ammonia, and numerous auxiliaries.

Thus another great synthetic plant joins the list of firms using Frick cooling equipment.

Whatever the refrigerating requirements of YOUR plant—air conditioning, process cooling or condensing, cold water, ice making, quick freezing, cold storage, or low temperatures — Frick engineers will help you design a system to meet your needs.



Butadiene condensers at Odessa, Texas

Call your nearest Frick Branch, Distributor or write to.....

* Patented

DEPENDABLE REFRIGERATION SINCE 1882

FRICK CO.

WAYNESBORO, PENNA., U.S.A.

New Equipment...

readily removed plate provides quick and convenient access to the Bourdon tube and movement assembly for inspection, recalibration or repair without the necessity of removing the indicator dial. Its weatherproof and durable, heavy-duty case of cast aluminum, is painted black for added corrosion resistance.

Equipped with the standard corrosion-resistant Helicoid movement, a simple cam and roller design that does not have any gear teeth to wear out, the gage provides long and trouble-free service with a minimum of maintenance. It is available in 4½ and 6-inch dial sizes. Pressures up to 20,000 pounds can be measured to a guaranteed accuracy of plus or minus ½ of 1 percent of full-scale range.

Four types of Bourdon tubes: phosphor bronze, alloy steel, stainless steel and K Monel are available to meet specific service conditions. Helicoid Gage Div., American Chain & Cable Co.

Circle E12 green card, last page

Polyester Catalyst Makes Odorless Urethane Foam

A new one-shot polyether catalyst used for producing odorless urethane foam, has just been developed. Dabco foams one-shot polyether systems, and can also produce foam from polyether pre-polymers, dimer acid esters, adipic acid esters, and co-polymers of dimers and polyethers and adipates and polyethers. It is also expected to have application in urethane coatings.

The catalyst is expected to supplant the costly, tedious pre-polymer techniques now being used in most urethane foam manufacturing. It can be used to foam any or all commercial polyethers to produce flexible, rigid or semi-rigid foams with a wide range of controlled properties.

Flexible foams produced with Dabco have low compression set, good properties of elongation, tensile, tear and shear strength, and exhibit excellent load-bearing characteristics. Houdry Process Corp.

Circle E13 green card, last page

Process Instruments Ready for Quick Shipment

A 52-page catalog on process instruments available for quick shipment has been published. The catalog covers indicators, transmitters, recorders and controllers for flow, pressure, temperature, density, viscosity and consistency.

Standard instruments are stocked at warehouses in Chicago, Atlanta, Houston, Los Angeles and Toronto, in addition to the main factory at Hatboro, Pa. Ordering has been simplified by assigning a number to each instrument or combination of instruments and prices of all such items are given in a separate, enclosed price list. Fischer & Porter Co.

Circle E14 green card, last page

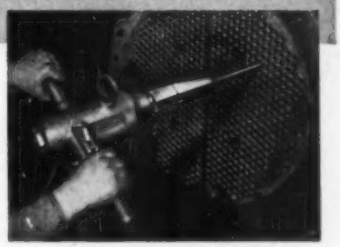
Data Processing Unit Price Barrier Broken

A major price break in the electronic computing industry was recently announced when a new data-processing system costing "significantly less" than comparable equipment now available, was introduced.

An accessory called the CA-2 for the low-priced G-15 digital computer has been developed that gives punched-card data-processing capabilities to the computer—

Keep Heat Exchangers on the Line with

WILSON Maintenance Tools



Heavy-Duty TP-301 Cleaner

Positive air-driven, hollow rotary shaft, drill type tool. Tube is scavenged with air or water while cleaning.

Tube Expanders

Wilson Models 41 and 44 Tube Expanders incorporate an improved, adjustable ball bearing thrust collar and are designed for efficient, easy rolling and maximum roll length adjustment for various tube sheet thicknesses.

Torq-Air-Matic Expander Control

New Wilson Torq-Air-Matic is the first and only air-driven tube expander drive that accurately controls tube expansion by directly measuring torque output at the mandrel.

Tube Cutter

Wilson tube cutter is easy to use and does a fast job. Cutter sizes and shanks available to meet all heat exchanger requirements.

Write today for your copies of Wilson Tube Cleaner catalog No. 77 and Wilson Tube Expander catalog No. 88.

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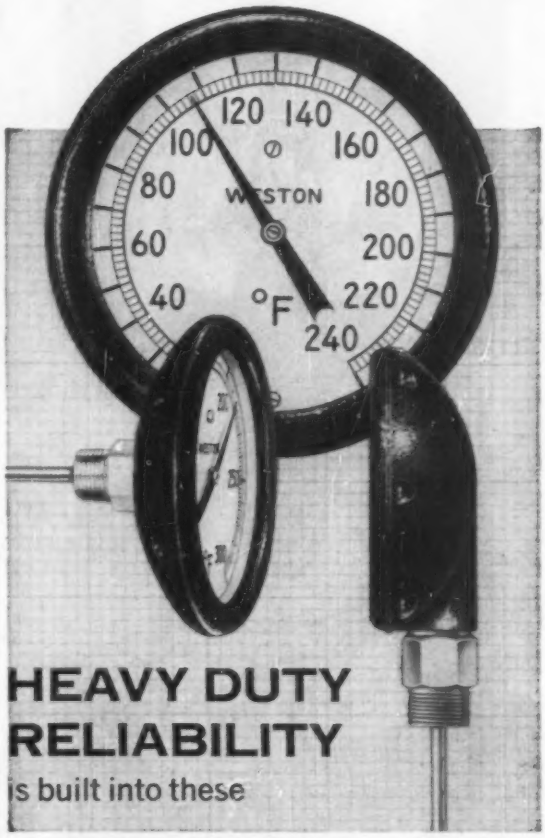
WESTON THERMOMETERS: STANDARDS OF STABILITY IN SCIENCE AND INDUSTRY



HEAVY DUTY RELIABILITY is built into these

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For lasting accuracy, even under punishing conditions, you can depend on Weston heavy duty bimetal thermometers. Exceptionally stable sensitive elements . . . corrosion-proof, pressure-tested stainless steel stems and connection nuts . . . rugged forged brass heads . . . suit these bimetals for the most strenuous service. Accuracy is assured within 1% of full scale range. 20 standard ranges: running from −100° to 1000°F or −100° to 400°C. Standard stem lengths from 2½″ to 72″.

Model 2221: has a 5" diameter head with 9" scale.

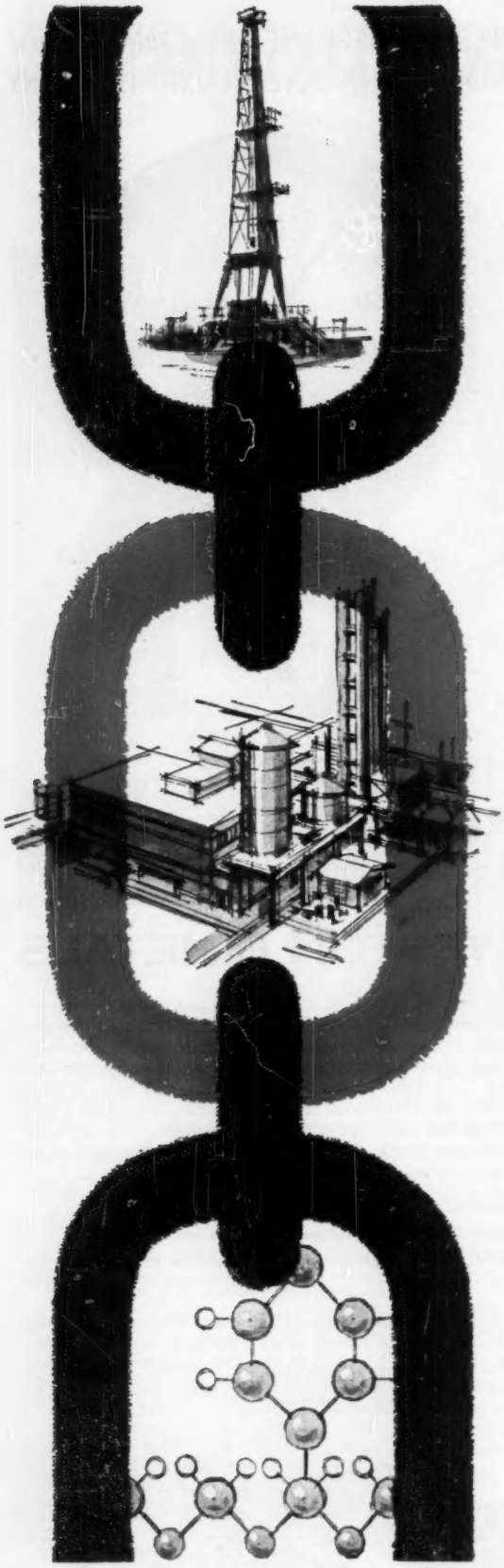
Model 2231: 6" diameter head with 12" scale.

Model 1221: straight form—basically the same as Model 2221, but with scale parallel to stem. Stem can be located in any one of 24 positions around the periphery of the head.

For full information, call your local Weston representative, or write to Weston Instruments, Division of Daystrom, Inc., Newark 12, N. J. *In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 10, Ont. Export: Daystrom Int'l., 100 Empire St., Newark 12, N. J.*

WESTON

A DAYSTROM UNIT *Instruments*



Blaw-Knox supplies vital link in Cosden's crude-to-plastic chain

From crude oil to ethylbenzene to styrene and finally polystyrene—with this pace setting program, Cosden Petroleum Corporation makes oil industry history. In designing and building Cosden's polystyrene plant, Blaw-Knox proudly joins this enterprising company in the vanguard of petrochemical activity.

A unique combination of know-how in resin manufacturing, chemical production and petroleum refining has made Blaw-Knox a leading contractor for industry's most progressive projects.

Perhaps this background of over 90 plastic and resins facilities can be helpful to you. Contact our engineering staff for a conference. Blaw-Knox Company, Chemical Plants Division with headquarters in Pittsburgh. Branch offices in New York, Chicago, Haddon Heights, New Jersey, Birmingham, Washington, D.C. and San Francisco.

for plants of distinction . . .

BLAW-KNOX

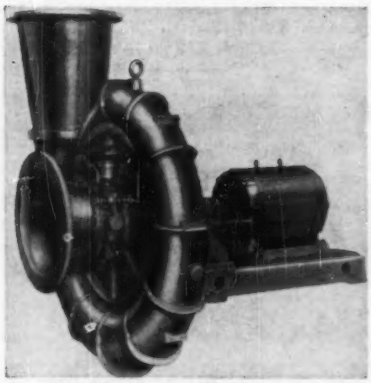
New Equipment . . .

capabilities formerly offered only by far more expensive machines, the company said.

The complete system—consisting of a G-15, the new CA-2, conventional card readers and punches plus a tabulator—will lease for about $2,500 per month, compared to $5,000 for currently used systems with similar capabilities.

The new equipment will enable smaller businesses, as well as present users of computing equipment, to obtain a compact, low-priced punched-card computing system with the same performance and versatility as medium-priced computing systems that are now widely used throughout the country. Bendix Aviation Corp.

Circle E15 green card, last page



Centrifugal Compressors Designed for This Industry

A new line of centrifugal compressors, designed specifically for refinery and petrochemical applications, is now being offered by Clark Bros. Co. Type OM units provide air service at low discharge pressures; Type OPB Series handles gas and air applications at higher discharge pressures. Sizes cover the 1,200 to 80,000 cfm range with input horsepowers from 10 to 2,500 bhp. Discharge pressures up to 900 psig can be readily handled in the lower capacity models.

Of ultra simple design, these single stage centrifugals are essentially constant pressure, variable volume machines. They can be used for blower service where inlet conditions are atmospheric; for exhauster service where inlet conditions are below atmospheric pressure; or for booster service where inlet conditions are above atmospheric pressure.

Features include: Heavy duty cases; overhung rotor construction; single shaft seal design; open or closed type impellers to meet various pressure and temperature requirements. Clark Bros. Co.

Circle E16 green card, last page

Computer Punch Cards Available from NGAA

Hydrocarbon phase equilibrium data on punched cards, rather than in the usual form of charts and tables, are now available to industry for the first time through the Natural Gasoline Association of America. Design and process engineers will be able to use these cards in computers to more quickly solve their complex and

CATAWISSA VALVE & FITTINGS CO.
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WASTE DISPOSAL PROBLEMS?

JOHN ZINK CO. HAS THE ANSWER . . .

John Zink Waste Disposal Units are custom designed to your specifications, for your individual application. Any size or capacity can be furnished for use in reducing liquid and semi-liquid wastes, or obnoxious gases. Available as a complete unit or burners only. John Zink Waste Disposal Units have been field-proven in process service throughout the world.

**The John Zink research furnace provides ideal test facilities for all custom-design work.*

Gas, Oil & Combination Burners / Inert Gas Generators
Air Heaters / Smokeless Field Flares / Mutes

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New Equipment . . .

time-consuming problems. The data, punched on cards for an IBM computer, were taken from the 130 K charts contained in the NGAA Equilibrium Ratio Data Book, 2nd edition, 1957, which presents data for 12 compounds (methane through decane) over a range of convergence pressures from 600 to 20,000 psia and a temperature range of from 500 F. to as low as —260 F. The card sets are to be sold to industry for use in electronic machine computations.

Actually, two different sets of cards are involved: the "Point" set and the "Coefficient" set. The former consists of 17,300 cards carrying a total of 69,200 points read from the NGAA charts. Each card has four punched points, all of which are identified on the card by component, convergence pressure, temperature and pressure. The "Coefficient" set consists of 432 cards with seven coefficients per card. Tables of these coefficients are included with the cards together with:

1. The flow sheet for machine solution of the equations.
2. The program used in the IBM 650 computer.
3. Suggestions for simpler methods when the problem requires "K" data for limited ranges of pressure and temperature, and,
4. A sample calculation which shows the solution of the power series equation.

These punched cards are being made available in several forms:

(a) The complete package which will include sets of both the "Point" and "Coefficient" cards.

(b) The set of "Coefficient" cards only together with the tables of coefficients, the curve fitting equations in which they are used, etc., as outlined above.

(c) Set of the "Point" cards only, and

(d) On special request, the data will be transferred to magnetic tape. Natural Gasoline Association of America.

Circle E17 green card, last page

Weldynamics

ARC WELDING AT WORK CUTTING COSTS

We welded 14 miles of Stainless Steel piping with Lincoln's Stainweld electrodes. All welds were tested under pressure, and I'd like to say that we have never had such good welds.'

Tom R. Gallagher

Houston, Texas

Your weldor's opinion is worth a thousand words

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The World's Largest Manufacturer of Arc Welding Equipment

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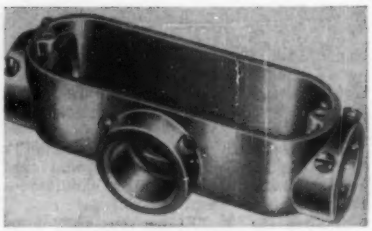
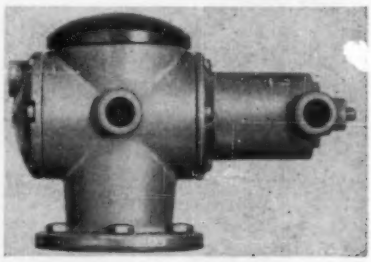


Conduit Fittings For Thinwall In New Sizes

The popular "Speedolet" thinwall fittings are now available in conduit sizes from ½ inch through 2 inches. These fittings can be installed quickly and permanently by simply tightening set screws. The screwdriver is the only tool needed on the job. They are perferred by many for their neatness as well as assured permanency. They are U.L. and C.S.A. approved. Killark Electric Mfg. Co.

Circle E18 green card, last page



Valve Positioner Matches Pneumatic Controller Speeds

The Model J. Positioner—a new and different valve positioner—is now available. A top mounted integral positioner, it is capable of matching or exceeding the speed and sensitivity of modern pneumatic controllers. It combines the proved force-balance design with a radically new pilot-operated relay valve, providing high power output and maximum sensitvity.

The Model J is an extremely versatile positioner suitable for use on both cylinder and diaphragm type actuators. It is capable of an infinite number of stroke lengths up to 8 inches in any combination of control forms through a variety of models. Linearity is guaranteed to be better than 1 percent regardless of stroke length. The Model J responds to signal changes as low as .001 psi. It is unaffected by vibration. Increasing or decreasing outputs may be applied to either the top or bottom of an actuator in a single mounting of the positioner. Zero adjustmen is readily accessible and can be made while in operation.

Completely enclosed and weatherproof, the Model J is suitable for use in the most adverse weather conditions and plant atmospheres. All moving parts are protected by an anodized aluminum housing with a corrosion resistant finish. Conoflow Corp.

Circle E19 green card, last page

Selective Hydrogenation Catalyst Purifies Olefins

A new type catalyst for the purification of olefin streams by means of selective hydrogenation has just been developed. High purity olefins, such as ethylene and propylene, are important raw materials for

The extensive fabrication programme of our Mechanical Engineering Division comprises among others

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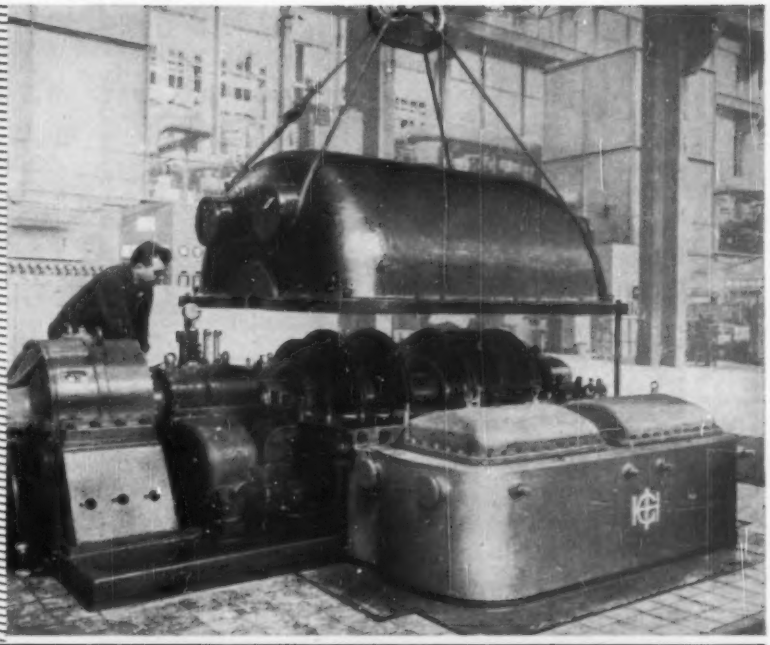

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HOW TO SOLVE *heat transfer problems*

Here is the book to give you a quick view of heat transfer fundamentals and the calculations of applying them in the design of such equipment as feed-water heaters, condensers, boilers, internal-combustion engine cylinders, and fan coils. Emphasizes basic aspects and immediately useful calculations!

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Introduction to HEAT TRANSFER

By **Aubrey I. Brown** and **Salvatore M. Marco**, both of The Ohio State University

Third Edition, 328 *pages*, 6x9, 70 *illus.*, $6.75

Engineers encountering a growing number of problems in this field will appreciate the directness of the treatment. Third edition includes new chapters on fluid flow in the convection process and graphical and numerical methods applied to heat conduction problems.

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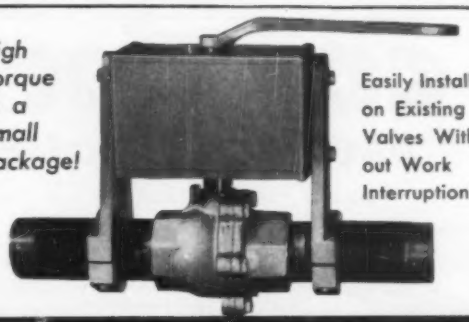

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For Remote or Hazardous Locations

Models for ¼" to 8" valves. Provides positive indicated control at any distance, yet allows manual operation or over-ride at any time. Operates on AC or DC by manual switch or automatic applications such as timer, thermostat, float, pressure switch, etc. In event of power failure, valve can be manually operated.

OPENS OR CLOSES BALL VALVES FROM ANY DISTANCE WITH THE FLIP OF A SWITCH

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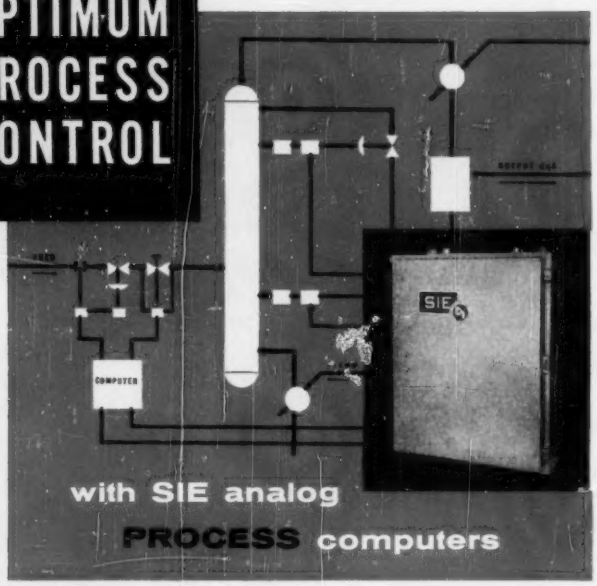

no ● moving parts
no ● vacuum tubes
no ● contacts

SIE CM-2 Analog Computers provide precise control in chemical, petrochemical, refining, and similar process applications, to a degree never before possible. Using this new concept, process variables are taken into account in adjusting set-points automatically to achieve optimum output yield.

Using Magnetic Amplifiers and Transistors CM-2 Series Computers have a **trouble-free life expectancy in excess of 100,000 hours,** yet in a typical fractionator application now in operation, computer cost was less than $5000.

Write for Brochure Describing Applications in Feed-Ahead, Feed-Back, and Operator Guidance computations. SIE engineers will welcome the opportunity to discuss the use of CM computers in your specialized process control applications.

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- Non-destructive to sealed element
- Completely adjustable immersion
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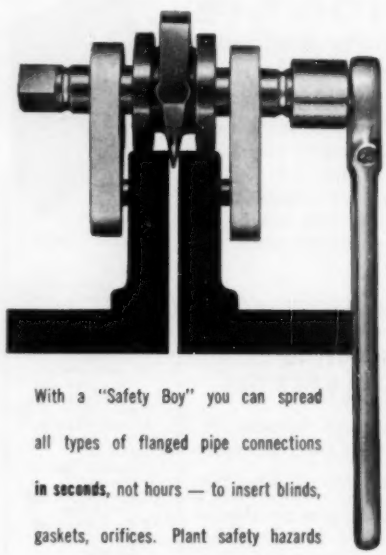

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"SAFETY BOY"
AT LAST! A TOOL TO SPREAD PIPE FLANGES SAFER — FASTER — MORE ECONOMICALLY — IN TIGHTEST WORKING SPACE.

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With a "Safety Boy" you can spread all types of flanged pipe connections **in seconds,** not hours — to insert blinds, gaskets, orifices. Plant safety hazards and costly down time are eliminated by switching to this really modern pipefitter's tool — "Safety Boy." Wherever there's piping there's a need for "Safety Boy" — the handiest tool ever invented for work in cramped quarters. Lightweight and easy-to-carry, "Safety Boy" is reasonably priced for wide usage.

the manufacture of polyethylene and the newer poly-propylene plastics.

The new catalyst designated as C36 Selective Hydrogenation Catalyst, contains nickel, cobalt and chromium on a rugged alumina support. It has been undergoing field tests in a large commercial ethylene plant since early this year and has continually demonstrated both high selectivity and activity for the hydrogenation of acetylene in raw sulfur-bearing ethylene streams. The C36 catalyst further combines the advantages of permitting high plant capacities without the need for frequent catalyst regeneration to remove deposited polymeric materials. Catalysts and Chemicals, Inc.

Circle E20 green card, last page

Data Manual Gives Safe Load Tables for Gratings

A new 20-page "Data and Specification" manual designed for the permanent libraries of engineers and plant supervisors has just been published.

The new manual, which took more than 1½ years to prepare, contains the newest safe load tables for welded and riveted gratings; data on new aluminum gratings; panel width constant charts; methods of anchoring; comprehensive tables on stair treads and methods of ordering grating.

It also covers the usage of floor armors as well as applications of ganister liners in the oil and petrochemical industries. Klemp Metal Grating Corp.

Circle E21 green card, last page

Pilot Plant Fractionator Developed in Research Lab

A new all-purpose fractionator for laboratories and pilot plants has been developed in the research laboratories of C F Braun & Co., called Perfo-Drip fractionating column. Chief advantage for the column is the ease with which it can be modified to perform a variety of services. It is made of Pyrex glass and is vacuum jacketed and silvered. Trays are perforated with 1/16 inch holes or ¼ inch holes. United Glassblowing Laboratories.

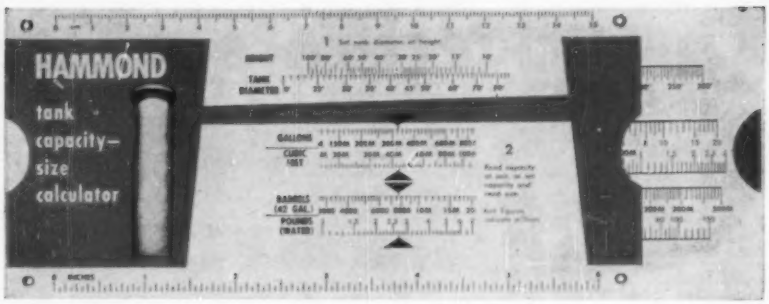
Circle E22 green card, last page

Data Sheet on Techniques In Gas Chromatography

Best techniques for increasing quantitative accuracy in gas chromatography are covered in detail in a new data sheet just published. Advantages of the peak or integrated area measurement and peak height measurement methods are given and several typical analyses are worked out in step-by-step fashion to show how each method is used.

The peak area technique is demonstrated with chromatograms run on a GC-2 Chromatograph and using a new type integrator. This integrator computes peak area within 0.1 percent accuracy and has been especially designed to operate with recorders used with the company's Gas Chromatographs. Beckman Instruments Inc.

Circle E23 green card, last page



Pocket-Size Calculator Gives Tank Size

A handy, pocket-size slide rule calculator for determining capacity and size of storage tanks is now available. It furnishes information on tanks up to 100 feet high and 300 feet in diameter. Capacities are given in gallons, barrels and pounds of water. Additional information obtainable with the Calculator includes: decimal equivalents of a foot for all inch units and fractions; equivalent volumetric units; and steel plate weights for thicknesses from 3/16 inch to 1 inch. Hammond Iron Works.

Circle E24 green card, last page

Fiber Glass in Housing Resists Corrosion

New fiber glass reinforced instrument housings which are light, strong, and corrosion-proof have just been introduced. The new housings are ideal for use in the chemical and allied industries where corrosion is a problem. Housings can be any color desired with color an integral part of the housing itself. Warmister Fiberglass Co.

Circle E25 green card, last page

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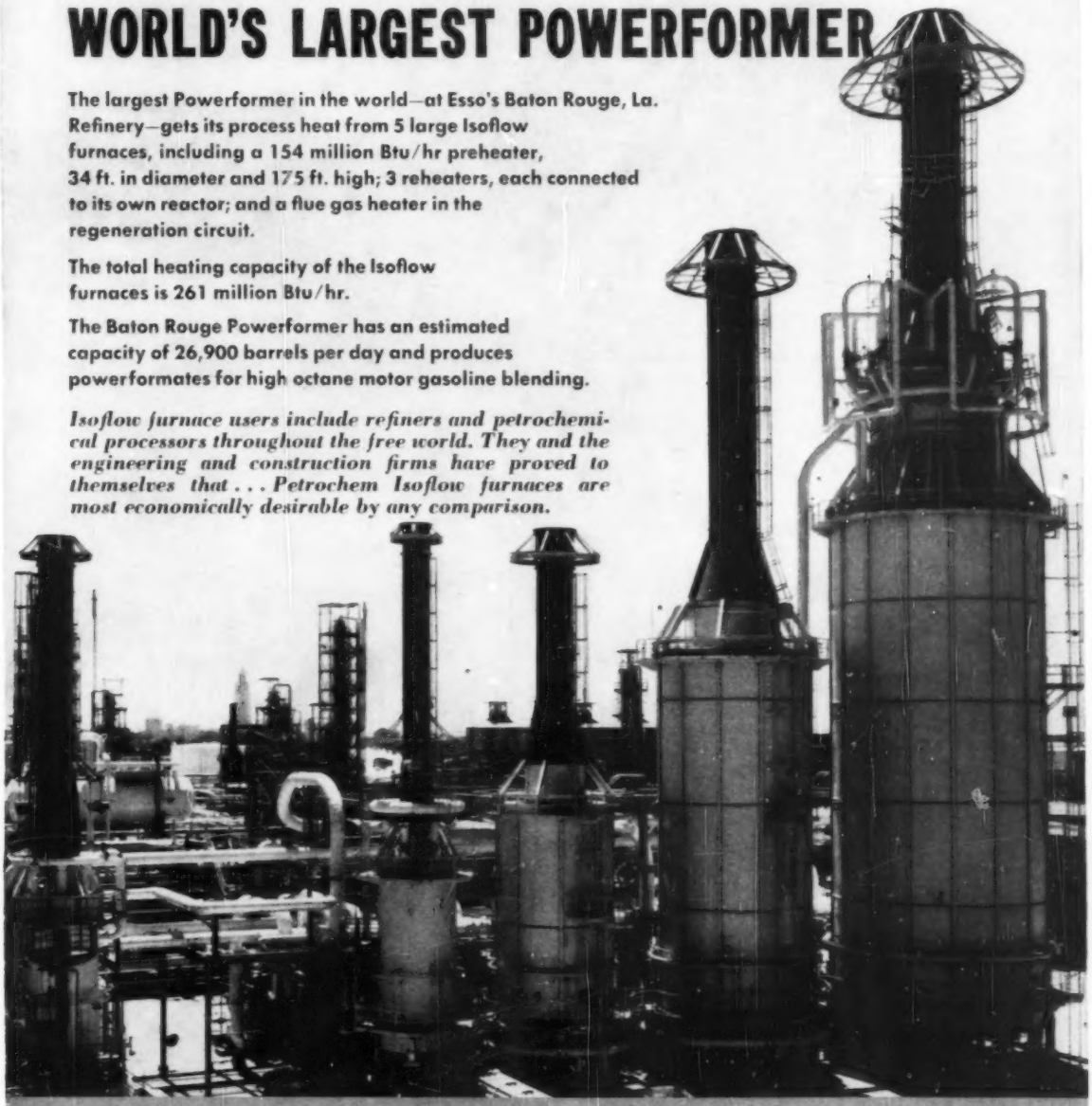

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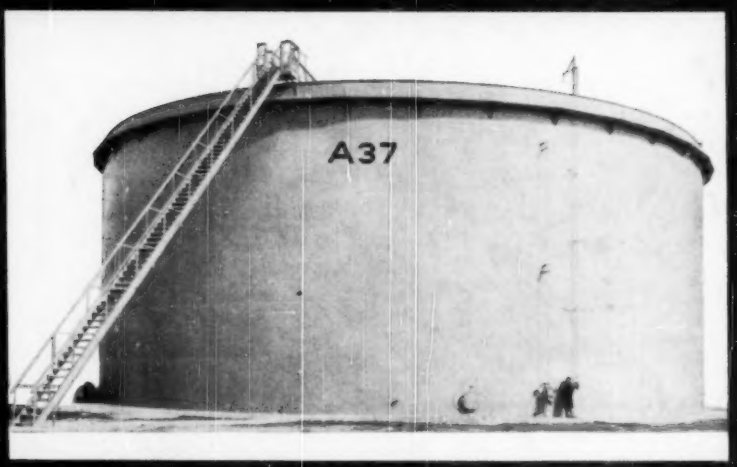

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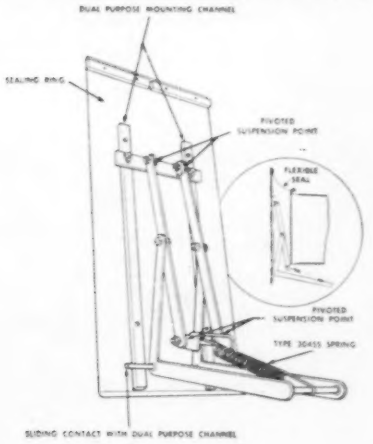

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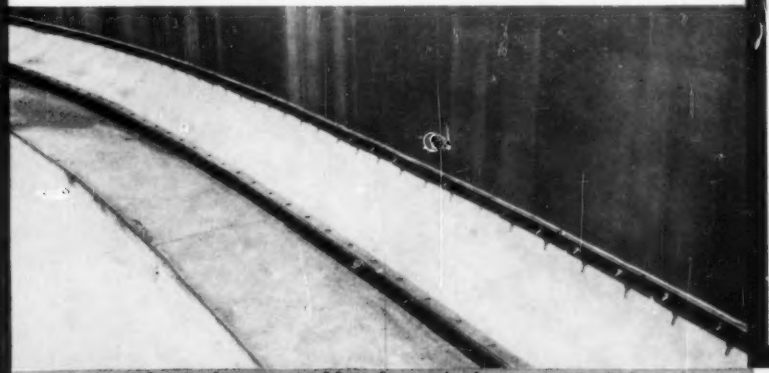

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